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ETHNOBOTANY SERVING SOCIETY: A CASE STUDY FROM THE SIERRA DE MANANTLÁN BIOSPHERE RESERVE

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ABSTRACT

The move to place biological diversity and traditional cultural knowledge into the mainstream global economy is based on the premise that economic subsidies will stimulate conservation. This premise is arguably counterproductive if the effects of such subsidies are not felt at the local level. Ethnobotanical research should focus on characterizing traditional knowledge to establish priorities with the local community to ensure that local values are translated into rational use of resources and effective conservation of biological diversity and cultural knowledge. A case study focussing on twenty-five of the most locally valued plants from a community in the Sierra de Manantlán Biosphere Reserve provides an example of recommendations that can be made based on basic ethnobotanical inventories.

RESUMEN

La tendencia a ubicar la diversidad biológica y el conocimiento tradicional dentro de la corriente de la economía global, se fundamenta en la premisa de que las subvenciones estimularían la conservación. Esta premisa resultaría contraproducente si los efectos de tales subvenciones no llegaran al nivel local. La investigación etnobotánica debería enfocarse en el uso del conocimiento tradicional para establecer las prioridades conjuntamente con la comunidad local, para asegurar que los valores locales se traduzcan en el uso racional de los recursos naturales, una conservación efectiva de la biodiversidad y el conocimiento cultural. Un estudio de un caso en una comunidad de la Reserva de la Biosfera Sierra de Manantlán, que examina veinticinco de las especies vegetales con mayor valor local, proporciona un ejemplo de las recomendaciones que pueden hacerse en base a la información de inventarios etnobotánicos.

Ethnobotany has arrived at center stage in the world of biological conservation and sustainable development (Alcorn 1995). The research efforts of ethnobotanists who document and analyze how people and cultures use and classify plants is now much more than an academic exercise, it has become a focal point for biological conservation (Wilson 1992) and sustainable

development (Reid et al. 1993). Chemical ecologists and natural product chemists have renewed interest in the research ethnobotanists and anthropologists conduct among traditional peoples from remote corners of the world. Renewed interest in ethnobotany stems from a new applied research field known as chemical or biodiversity prospecting (Eisner 1990; Eisner & Beiring 1994; Reid et al. 1993; see also Balick 1994; Cox 1994; Farnsworth 1994). Prospecting refers to the identification and use of previously unstudied genes and the primary and secondary metabolites of organisms that can remedy existing human illness or improve well-being by reducing loss due to crop pests, or by simply increasing the yield of our few cultivated crops. Entrepreneurs hope that placing biodiversity and diverse cultural knowledge into the mainstream global economy, nature's products will facilitate treatment of the many ills that befall society today and at the same time will help us to avert the human induced surge of biological extinction.

The biological conservation agenda (Wilson 1992) sees the importance of biological diversity from this same vantage pointing out that the utilitarian or economic argument is the strongest in favor of conservation. The valuation of biological diversity will help to avoid extinction which reduces our ability to confront existing and future social costs such as producing enough food, and curing existing and unforeseen disease. There are myriad other arguments that form part of this agenda that hinge on the indirect values of biological diversity or ethical issues such as the right of one species to extinguish another. However, the value of biological diversity has become a central issue among conservationists. And many development efforts today are investing in biological diversity banking on the possibility that this vast store of natural products might yield the gene sequence or new chemical compounds that will revolutionize plant industry or health care possibilities. Many conservationists believe that the value of such discoveries can be translated into far-reaching conservation efforts. We believe they can. However, the economic argument has significant consequences both for ethnobotany as a discipline and ethnobotany's long-term integration with biological conservation.

Placing ethnobotany and ethnobotanists in this situation may have created a gold rush mentality that is justified because extinction rates are higher than ever before and are increasing most dramatically where biological diversity is greatest. We hope that is not simply an accommodation to global economy that will subject the discipline to the ultimate risk of any fad, viz. waning long-term interest. If we cannot save it, perhaps we can at least model the chemical structure of its secondary metabolites and gain insights that will improve our survival possibilities. The risks of losing future options makes ethnobotanical research worth the investment (Martin 1994; King & Tempesta 1994).

An equally important justification for ethnobotanical research is no less academic than chemical prospecting but is complementary and practical. Ethnobotanical research should not focus solely on the big ticket items but also on a more general knowledge of local plant use because such information is relevant in regional land use planning frameworks to ensure rational use of natural resources at the local level and provide the basis for sustainable conservation programs. Efforts to conserve biological diversity are contingent upon the willingness and capacity of the local human population. Willingness is determined by the value the biota has to the local community. Capacity is determined by the local communities' ability to translate this value into realistic economic terms. Loss of traditional knowledge about utility of the local biota hinders conservation efforts because the local population may no longer consider the biota or its utility valuable or lack the ecological capacity to translate it into relevant social and economic terms. Ethnobotany should be conducted within this conservation-development framework because effective conservation of biological diversity depends on the individual or community's ability to apply their own culturally relevant cost-benefit analysis of conserving or extinguishing the local biota in attempting to resolve local community problems. The best justification for conducting ethnobotanical research is simply that such research is one way of assuring that arguments in favor of conserving local biota are based upon local values.

Here we provide one example of how ethnobotanical research can be used in integrating conservation and development. This example provides a short list of plant species with local value and recommendations of how such uses might be integrated into a community forestry project in a Biosphere Reserve in western Mexico.

The Sierra de Manantlán Biosphere Reserve (SMRB) is an integrated conservation and rural development project in southern Jalisco and Colima, Mexico (Graf et al. 1995; Jardel 1992). The SMRB developed out of the discovery of a wild perennial relative of corn (maize), *Zea diploperennis* Iltis, Doebley and Guzman. This species was discovered in a very restricted area of agricultural lands in the community of Ayotitlán in Manantlán (Benz et al. 1990; Iltis et al. 1978). The combination of the potential economic value of this endemic species, the extremely rich biota of Manantlán (Jardel 1992) and the social and economic problems of the rural populace led to the creation of a research institute by the University of Guadalajara devoted to the administration of the Reserve in 1985 and the establishment of the Reserve by federal decree in 1987.

This biosphere reserve extends across the community-held lands of twenty-eight *ejidos* or indigenous communities and the private properties of seventy families. Creation of this reserve did not change land tenure, but

it did place limits on land use in certain areas. The reserve's buffer zone has guidelines for natural resource use while natural resource use is prohibited in the core zone.

The area's biological diversity is especially significant with more than 2770 vascular plant species and 560 species of vertebrate fauna occurring in at least nine distinct types of vegetation (Vazquez et al. 1995). Agriculture and animal husbandry have been the dominant forms of livelihood in spite of the fact that the area is dominated by forest ecosystems. During the last century, utilization of Manantlán's forests has increased in importance. Unfortunately, the area's rural communities did not receive the economic benefits that resulted from forest exploitation during the last fifty years, because the concessionaires frequently avoided paying the appropriate tax, or the community as a whole was not the recipient of such a tax (Jardel 1992). There can be little doubt that the area's principal vocation is forest use. From a conservation and development standpoint it should be stressed that use of the forests must be primarily for the benefit of the local population which must counterbalance use with maintenance of existing biological diversity.

At present only a single community in the Sierra de Manantlán Biosphere Reserve (SMBR) holds a permit for commercial timber extraction. Most community lands in the Reserve are subject to harvesting of forest products by the local population because these activities are alleged to have less impact upon the forests than commercial timber harvesting and they are not regulated by existing legislation. The single community holding a commercial permit, El Terrero, is an *ejido* of ca. 3000 hectares with a population of 360 which operates its own saw mill.

The *ejido* of El Terrero is located on top (between ca. 2000 and 2500 meters above sea level) of the Cretaceous-age massif known locally as Cerro Grande located at the east end of the Reserve. Forests are composed of mixtures of pines and oaks while the highest altitude peaks are forested by fir (*Abies* spp.) and cypress (*Cupressus lusitanica* Mill.) and the protected drainages are blanketed by diverse and relictual stands of Montane Mesophytic Forest (Rzedowski 1988).

A management plan for the *ejido*'s forest was drafted by the University of Guadalajara's Instituto 'Manantlán' de Ecología y Conservación de la Biodiversidad (IMECBIO) under agreement with the community (Jardel et al. 1995). This management plan and accessory environmental impact statement are a prerequisite for commercial logging. This plan establishes the parameters of cutting, monitoring actions and mitigation alternatives in the event that exploitation has adverse effects on existing natural or cultural heritage. One of the appendices to the management plan included an ethnobotanical evaluation of the area's flora and vegetation. This techni-

cal document, which is the basis for this essay, was made available to the *ejido* assembly to complement the economic and ecological plans for harvesting timber from the *ejido*'s forests. The focus of the aforementioned appendix was to recommend forest product use from the results of ethnobotanical research that might satisfy some of the *ejido*'s immediate needs. Readers interested in the specifics of timber harvesting are referred to the original management document (see Jardel et al. 1995).

ETHNOBOTANICAL RESEARCH GOALS AND METHODS

Ethnobotanical inventory in the Sierra de Manantlán was undertaken to assess the variation in cultural knowledge about the area's flora, determine the effects of current utilization on the area's flora, and to systematically record ideas, species and traditional management techniques that could suggest land use alternatives that would ensure a more rational use of resources (Benz et al. 1994, Jardel 1992:257–265). The needs of each local community were given first priority based on the premise that this focus would gain community support for any subsequent proposed actions that might be needed to mitigate conservation problems. Hence species occurring in the immediate vicinity of the communities - those occurring within a two kilometer walking distance - that were identifiable (i.e. had flowers or fruits), were used in interviews during our short but seasonal visits. The general inventory was concerned with recording and analyzing the diversity of ethnobotanical knowledge using a systematic method of data collection (details of collection, interviewing, and data management are provided in Benz et al. 1994).

Persons providing information were informed of the goals of this project and of its relevance to the implementation of the Reserve's management plan. While not all informants were in complete agreement with the Reserve's objectives (principally because of potential conflicts over land tenure), all who agreed to collaborate provided information on plant use knowing that it was being collected to assure its conservation and would be made available to them upon request. Our own interest in the systematic collection of this information included securing alternatives that might assist in resolving existing and future needs of the community, as well as for seeking solutions to the needs of other communities in the Reserve. We felt justified in considering alternatives for all communities because of the need to conserve the biota in the Reserve as a whole, not just that in any one community even though information discussed here was elicited from El Terrero informants using species that occur in close proximity to the community.

Of the 517 plus species occurring in the forests of El Terrero, at least 152 of the 253 species used in informant interviews have been designated

as useful. A total of 43 informants (17 males, 46.3 ± 14.4 years old, range 21 to 72 and 26 females, 37.3 ± 17.5 years old, range 12 to 88) were interviewed over a four year period. On average each provided 8.4 ± 10.6 reports of use for all of the species used in interviews (see Benz et al. 1994). Each species was recorded as useful by an average of 5.3 ± 4.9 informants. Eleven species were recognized as useful by more than 15 informants and thirty-six species reported as useful only once and by a single informant.

Importance values were calculated to provide each species with a relative measure of local use value based upon the assumption that the total number of reports of use, the sum of the different types of use and the total number of informants agreeing that a species is useful provide appropriate measures of a species' usefulness to the community (Benz et al. 1994; Phillips & Gentry 1993; Phillips et al. 1994; interested readers should consult the original articles for details on calculating these indices). These importance values have been utilized as a means for recommending species based on the belief that a higher value indicates the species has greater relative importance to community members and thus has greater potential for resolving community needs.

Relevant information of a species' utility also comes from outside the community. A local herbal remedy (or other specific use for a species) that is used throughout the country (hence our frequent citation of Mexico's Instituto Nacional Indigenista publication on medicinal plants [INI 1995]) leads us to suggest that potentially greater economic benefit might be available to the community if greater investment was made to increase production and/or distribute the product more widely. Such occurrences need to anticipate demand and plan production to ensure the local resource is not over exploited. In a similar fashion, when a particular species is locally preferred for a specific use, e.g., house construction, recommendations for its extraction or planting need to be contemplated in anticipation of community needs.

Recommendations are offered for the *ejido* of El Terrero in its entirety. The forest management plan proposes timber harvesting in only a fraction of the total *ejido* area (Jardel et al. 1995). Because the habitat requirements of some plant species are found only in certain vegetation types and these will probably not be subject to timber exploitation, some recommendations may seem out of place. It should be made clear that our recommendations were offered for planning management of all the *ejido*'s forests, not only those slated for timber harvest. Furthermore, the data on which these recommendations are based are derived from existing knowledge and patterns of resource use. Our recommendations attempt to integrate these traditional patterns with recommended timber harvesting schedules. Recommendations for many species will have to be made compatible with the *ejido*'s forest management plan, restricting, for example, exploitation of

species found only in Mesophytic Forest which is protected by standards outlined in the Reserve's Management Plan.

The forest management plan divides the *ejido's* 38 most common tree species into four management categories (Jardel et al. 1995). A single species of oak, *Quercus crassipes* Humb. & Bonpl. is included in Category I, the species considered most significant for timber production. One of the species included in Category 2 of the *ejido's* management plan and in our short list, *Q. obtusata* Humb. & Bonpl. (Table 1 and 2), is recommended for exploitation, not for lumber, but for cellulose, firewood or charcoal. Three of the species listed in Table 2, *Arbutus xalapensis* McVaugh and Rosatti, *Prunus serotina* Ehrh. and *Ternstroemia lineata* DC. are included in Category 3 which are destined for producing firewood, charcoal, posts, cellulose and wood-working because the species occur on *ejido* lands in low volumes. Other tree species considered below (Table 2) are placed in Category 4 of the *ejido's* management plan. Exploitation of natural populations of these species is restricted because the species are rare, regeneration is low, or current legislation or reserve management guidelines mandate special protection. The species listed in Tables 1 or 2 and included in this category are *Q. laurina* Humb. & Bonpl., *Q. rugosa* Nee, *Alnus jorullensis* H.B.K., *Cercocarpus macrophyllus* C. Schneid., *Styrax ramirezii* Greenm., and *Symplocos citrea* Lex. Species listed in Tables 1 and 2 and not mentioned above are not given additional management recommendations by Jardel et al. (1995).

ETHNOBOTANICAL RECOMMENDATIONS FOR EL TERRERO

It should be made clear that we have not yet validated the efficacy of the traditional remedies or determined the economic feasibility of marketing additional quantities. The former will require extensive toxicology and clinical evaluations which will be undertaken in the future. Marketing of plant products from the species described below has been a subsistence endeavor of the local people for many years. Unfortunately, harvest and sale of some may have given them an unfair market advantage that clandestine exploitation offers (i.e. no limits on harvest quantities, no payment of institutional overhead, sale at unofficial rates). Whether increased production of these products through managed exploitation can be accommodated in existing markets will require a detailed market evaluation. However, interviews with retail and wholesale vendors have established the existence of local, regional and national markets that are far from saturated with the products that might be available from El Terrero. Literature citations are provided to indicate that certain uses have persisted over time or that other markets may have existed in the past. Recommendations are offered to suggest that local processing of marketable plant products appears to be feasible because the market is already known to exist.

TABLE 1. Useful plant species from the ejido of El Terrero with values greater than two standard deviation units from the mean for one or more indices of importance. Most species are included because their values on Phillips' overall use value exceed 2s. The importance values listed include: number of reports of use from all informants (Reports; see Benz et al. 1994), total number of informants that identify the species as useful (Infos), the number of occasions when the species was presented to an informant to elicit information (Events), the number of general categories the plant is used for (of thirteen possible), and use value and overall use value described in detail by Phillips and Gentry (1993:19).

Taxon	Reports	Infos	Events	Uses	Use Value	Overall Use Value
<i>Prunus serotina</i>	73	21	24	69	61.0	2.9
<i>Quercus laurina</i>	48	19	25	45	34.7	1.8
<i>Symplocos citrea</i>	39	14	18	37	28.5	2.0
<i>Styrax ramirezii</i>	39	17	24	38	26.2	1.5
<i>Rubus adenotrichos</i>	35	17	22	34	26.5	1.6
<i>Ternstroemia lineata</i>	32	12	14	26	23.5	2.0
<i>Baccharis pteronioides</i>	30	19	19	27	27.0	1.4
<i>Comarostaphylis discolor</i>	30	12	16	30	21.5	1.8
<i>Celastrus pringlei</i>	28	18	23	28	22.5	1.2
<i>Rubus pringlei</i>	27	17	18	24	23.0	1.4
<i>Crataegus pubescens</i>	26	12	12	24	24.0	2.0
<i>Smilax moranensis</i>	25	16	20	24	19.5	1.2
<i>Quercus rugosa</i>	22	9	10	22	20.0	2.2
<i>Quercus obtusata</i>	17	5	5	13	13.0	2.6
<i>Fragaria mexicana</i>	16	16	16	16	16.0	1.0
<i>Quercus scytophylla</i>	13	5	5	13	13.0	2.6
<i>Cercocarpus macrophyllus</i> *	11	5	5	10	10.0	2.0
<i>Quercus crassipes</i> *	6	3	3	6	6.0	2.0
<i>Xylosma flexuosum</i> *	4	2	2	4	4.0	2.0
<i>Zanthoxylum arborescens</i> *	2	1	1	2	2.0	2.0

* These species have been eliminated from Table 2 because they have importance values that although significant appear to be an artificially high because the number of different uses is exactly twice the number of informants.

The order of presentation of the species is based on Table 1, the order of local importance based on relative use values calculated from reports of use elicited from the inhabitants of El Terrero.

Capulín, (*Prunus serotina* Ehrh.) is a widespread but locally rare tree occurring in the Mesophytic, *Abies*-Pine-Oak and Pine-Oak Forests of the *ejido* of El Terrero. It is used for a wide variety of purposes by the local population (Tables 1 and 2). The fruit is highly appreciated for making fruit drinks and punches. The bark and less often the leaves and flowers are prized ingredients for preparing cough remedies, and treating abdominal pain and diarrhea among other ailments (INI 1995; Hill 1952). The wood has been worked into fine furniture and cabinetry in the past (Hill 1952) but because of limited availability it has fallen into disuse.

The bark and leaves from felled trees should be collected and processed for sale. The wood of this species was previously used for furniture and

TABLE 2. Twenty-seven plant species recommended for incorporation in forest exploitation program for the *ejido* of El Terrero based upon importance values, their potential in *ejido* forestry programs and the existence of a local market for some or all of a species' products. The uses listed are arranged in order of the frequency in which they were elicited.

Taxon	Local Uses
<i>Prunus serotina</i>	Edible, medicinal, construction, firewood, furniture, forage, fence posts, instruments
<i>Quercus laurina</i>	Construction, firewood, instruments, furniture, forage, medicinal, edible, fence posts
<i>Symplocos citrea</i>	Edible, instruments, construction, forage, fence posts, furniture
<i>Styrax ramirezii</i>	Forage, construction, edible, firewood, instruments
<i>Rubus adenotrichos</i>	Edible, medicinal, forage
<i>Ternstroemia lineata</i>	Medicinal, construction, firewood, fence posts, instruments
<i>Baccharis pteronioides</i>	Instruments, medicinal, forage, edible
<i>Comarostaphylis discolor</i>	Edible, firewood, fence posts, forage, furniture
<i>Celastrus pringlei</i>	Forage, edible
<i>Rubus pringlei</i>	Edible, medicinal, forage
<i>Crataegus pubescens</i>	Edible, medicinal, forage
<i>Smilax moranensis</i>	Edible, forage, instruments
<i>Quercus rugosa</i>	Edible, firewood, instruments, forage, construction
<i>Quercus obtusata</i>	Construction, firewood, forage fence posts, furniture
<i>Fragaria mexicana</i>	Edible
<i>Quercus scytophylla</i>	Construction, edible, forage, medicinal, furniture, firewood
<i>Alnus jorullensis</i>	Instruments, firewood, construction, fence posts, forage, medicinal
<i>Arbutus xalapensis</i>	Medicinal, instruments, firewood, furniture, forage, edible
<i>Marrubium vulgare</i>	Medicinal
<i>Sambucus mexicana</i>	Medicinal
<i>Lepechinia caulescens</i>	Medicinal
<i>Buddleia sessiliflora</i>	Medicinal
<i>Gnaphalium americanum</i>	Medicinal
<i>Myrcianthes fragans</i>	Edible, medicinal, construction

cabinetry and also as support bases for scientific instruments, for making patterns and turnery (Hill 1952:97) because of the beauty of its grain and the ease with which it is worked. While many of the uses of this wood are no longer competitive, the beauty and ease of working will always be appreciated. Local use in furniture manufacture would appear to be a promising enterprise. Anticipating relatively low quantities in existing forests leads one to suggest that this species be incorporated into nurseries.

The encino chilillo (*Quercus laurina*) is one of the oak species listed in Category 4 of the *ejido*'s management plan that show potential but whose merits have not yet been evaluated. The species occurs principally but not exclusively in Mesophytic Forest. Apart from the wood being highly prized for construction timber, firewood, tools, furniture, and fence posts, its acorns are a preferred fodder and acceptable foodstuff, and its bark is widely appreciated in Mexico for treating tooth-aches, diarrhea and other less commonly cited maladies (INI 1995).

Exploitation of this species should consider harvesting the bark as soon as

the tree is felled. It should be dried in the shade if sold for commercial purposes.

Symplocos citrea Lex., or Chico, is a medium to large tree occurring most frequently in Mesophytic Forest. The most frequently cited use by the local inhabitants is for its edible fruits, consumed both by humans and domestic animals. Other reports refer to use of the wood which is suitable for tool handles, construction timbers and fence posts. No reference is made to its use as firewood.

Felled timber might be used first to satisfy domestic construction and fencing needs. Consumption of the fruit is widely acknowledged suggesting that nutritional evaluation would be useful to determine its potential as a foodstuff. Fruit-harvesting does not appear to be intense enough to warrant concern or regulation.

Palo de Casa (*Styrax ramirezii* Greenm.) is a small understory tree found principally in Mesophytic Forest. Leaves and small branches are used as fodder for domestic animals and the stout branches and trunk are preferred for use in house construction, hence its common name. Populations of the species might need to be monitored if house construction increases.

Two species of blackberry (zarzamora, *Rubus adenotrichos* Schlecht. and *R. pringlei* Rydb.) are actively collected in El Terrero. Both species occur in Mesophytic Forest while the latter also appears as an element of Oak Forest. The acid fruits are used in fruit drinks and liqueurs and the leaves, branches and roots are prepared to treat diarrhea (INI 1995).

Both species are colonizers of forest openings and aggressively hold territory once established. Openings in Oak forest created by timber harvesting might be planted initially with blackberry while regeneration is underway. Cultivated populations would probably have to be managed under such conditions to ensure that pine or oak seedlings are not affected. Collection and sale of fruits from natural populations is a very remunerative activity that would be greatly enhanced through cultivation. Harvest of leaves or the roots for sale as ingredients in traditional remedies would be possible once forest regeneration had begun to limit fruit production.

Tila or Jazmincillo (*Ternstroemia lineata* DC.) is a common understory tree of the Oak and Mesophytic Forests on *ejido* land. The most common use of the species is as a medicinal remedy (INI 1995) although its wood is also used for construction timber, firewood, fence posts and tool handles. Fruits and flowers (actually the sepals and pistil that persist after the corolla has fallen) are collected during the dry season from trees in forest clearings, along roadsides and in house gardens, dried, and sold. Although collection may involve all members of the family, women and children devote substantially more time to all aspects of commercialization than men. A large national market exists for the flowers and fruits of tila.

Tila is a shade tolerant species that is widespread in the forests of the

ejido. Exploitation of the wood is contemplated in the *ejido*'s management plan. The wood is reported to be useful for construction and firewood, less so for fence posts or tool handles. Cultivation of the species for its wood does not appear to be a priority (Jardel et al. 1995) due probably to its ecological requirements and a lack of known marketability. Integrating the species into management of the forests should be sought knowing that a national market exists for the fruits and flowers, and that members of the community already devote considerable time to collection and commercialization. Integration may be difficult because tila is a late successional species and does not produce well under such natural conditions. One alternative might be to plant it in openings along logging roads and along the margins of clearcuts. Cultivation in such open areas might permit greater fruit production earlier than normal allowing flower and fruit collection during periods when forests in adjacent areas are regenerating. A second alternative might be to experiment with mixed plantings of oak and tila thinning tila as the oaks begin to dominate.

Baccharis pteronioides DC. (cuaracata) is an understory shrub of *Abies* Forest. It is locally prized for making brooms and for use in medicinal remedies. Domestic needs appear to be satisfied without undue pressure on local populations. Insufficient information is available to determine whether the species might be cultivated for medicinal purposes.

Madroñillo (**Comarostaphylis discolor** (Hook.) Diggs), is an understory shrub that occurs in Mesophytic Forest. The fruit is edible and the wood is commonly used for firewood and fenceposts. Fruit palatability appears to be quite variable suggesting that nutritional profile and palatability studies be made if the species is considered a candidate for managed production.

Celastrus pringlei Rose (bejuquillo relumbroso) is a canopy liana occurring principally in Mesophytic Forest. It often appears in clearings and along roadsides throughout the *ejido* as well. It is one of the locally preferred forage plants and the aril is also edible. The bark is infrequently reported to have medicinal properties.

The importance of the plant as a forage is widely recognized suggesting that when stands destined for logging that contain the species are located, harvest of the foliage should take place prior to logging to ensure that the felling of large canopy trees acting as supports for this and other lianas (e.g. see *Smilax moranensis* below) will not disturb subcanopy trees. Such harvesting could satisfy some of the forage needs of families that possess livestock.

The edible fruits of tejocote (**Crataegus pubescens** (H.B.K.) Steud, also known locally as manzanillo) are widely appreciated in Mexico as an ingredient in holiday punches. The fruits are widely sold in markets though price differentials for larger cultivated varieties and wild collected fruit are

not apparent. This species occurs in disturbed areas, as well as in Oak and Mesophytic Forests. The roots of tejocote are also very widely harvested for medicinal purposes for a vast array of illnesses and extracts are known to have cardiogenic activity (INI 1994).

This species could be cultivated more widely in the *ejido* especially in abandoned *milpas* and pastures. It has a significant though seasonal local market that is otherwise satisfied with fruit transported from regional market centers. Local focus on extraction of roots for medicinal purposes may have had a negative impact on existing populations. Determination of the efficacy of extracts from other parts of the plant could be an especially timely undertaking to anticipate and understand the impacts of root harvesting.

Asierrilla (*Smilax moranensis* Martens & Galeotii) is a canopy liana apparently restricted to Mesophytic forest. It is highly esteemed locally as an edible green (Cevallos 1992). Medicinal use of the roots is well-known in other parts of Mexico (INI 1994) as is that of tropical relatives (Arvigo & Balick 1993).

If restricted to Mesophytic Forest, it is unlikely that this species will be encountered in forests destined for timber harvest. Cultivation of the species in clearings and house gardens is suggested should collection of local stands ever intensify. The root of the species is commercialized throughout Mexico. Harvest of populations existing in logging tracts should be planned in anticipation of cutting for reasons already mentioned in the case of bejuquillo. Market evaluation should be undertaken if pharmacological activity shows promise. The species is extracted from natural stands in other parts of Mexico suggesting that protection may be necessary in the future.

Two additional species of oak (avellano, *Quercus rugosa* Nee and roble negro, *Q. obtusata* Humb. & Bonpl.) are widely recognized as useful by the people of El Terrero. Jardel et al. (1995) report both from a variety of forest types in addition to Mesophytic Forest. Avellano (roblillo in Jardel et al. 1995) is most frequently reported for its edible acorns and less frequently for the multiple uses of its wood while roble negro is more often identified for the usefulness of its wood or the medicinal value of its bark (INI 1995). The latter species is included in Category 2 in the *ejido's* management plan and will probably be exploited commercially.

Harvest and commercialization of the bark of *Q. rugosa* should be considered if the species is incorporated into timber harvesting cycles. Use of oak barrels for aging tequila or mescal might be pondered as a viable market for the wood of these oaks. The fact that *Q. rugosa* has edible acorns implies that acorn production of this species and perhaps other oak species might be systematically harvested by livestock (cf. Peattie 1950:210–211).

Fresa cimarrona (*Fragaria mexicana* Schlect.) is an herb found principally in *Abies* or Pine-Oak Forests. Its edible fruit are widely appreciated

but the plant does not produce sufficient quantities nor large enough fruits to merit large-scale systematic harvesting nor commercial production. The populations found in El Terrero may be useful as a source of germ plasm.

Roble negro (*Quercus scytophylla* Liebm.) is a canopy tree that occurs principally in Mesophytic Forest. The utility of its wood is well-known though it is just as likely to be mentioned as a source of edible fruit or for its medicinal bark. The same recommendations made for *Q. rugosa* or *Q. obtusata* can be made for *Q. scytophylla* though its distribution in Mesophytic Forest will probably restrict its exploitation.

Aile (*Alnus jorullensis* H.B.K. subsp. *jorullensis*) is a medium-sized tree occurring in *Abies*, Pine-Oak Forests and Oak Forests. It is prized locally for tool handles fabricated from its wood as well as for its use as a construction material and for fuel. Leaves and wood are used medicinally in Puebla and Sonora (INI 1995). It is reported least frequently as a forage in El Terrero.

The species might be useful in restoring degraded areas as a forage because it is known to grow with associated nitrogen fixing organisms (Langenheim & Thimann 1982; Noggle & Fritz 1976).

Madroño (*Arbutus xalapensis* McVaugh & Rosatti) is a locally rare but widely occurring medium-sized tree found in most all forest types in the *ejido*. It is recognized locally for the medicinal properties of its bark. A related species is used medicinally in the state of Baja California Sur. The wood is very hard and has recognized potential for tool handles, furniture or firewood.

This species is included in Category 3 of the *ejido*'s management plan, hence exploitation of its wood is anticipated. Local use of the bark for medicinal purposes might signal economic potential.

Five of the six species added to Table 2 are discussed here because most have known market value and are commercially exploited for the national medicinal plant market (INI 1995) even though their use value indices are not significantly greater than the norm. Local vendors in Jalisco and Colima obtain these plants from wholesale markets (Los Abastos, in Guadalajara) or from local collectors. All five species occur in forest openings or disturbed areas. Three of the five (*Marrubium vulgare* L., *Lepechinia caulescens* (Fernald) Epling, *Buddleia sessiliflora* H.B.K.) are aggressive perennial weeds and could be cultivated in forest clearings prior to or during replanting and regeneration and harvested very intensely once the regenerating tree species establish themselves. The last species in Table 2, (*Myrcianthes fragrans* (Sw.) McVaugh) is a small to medium-sized tree that occurs in Mesophytic Forest. The fruits are consumed fresh or used to make fruit drinks. The species is highly esteemed as a flavoring agent and medicinal species and shows great potential for commercial use in herbal teas. Consideration might

be given to intensifying fruit production in areas that are opened up through clear-cutting by planting the understory after the forests have regenerated.

It should be noted that many of the species listed in Table 2 that have economic value individually, could be combined and commercialized as herbal teas or as traditional remedies. For example, Sauco (*Sambucus mexicana* Presl.), is a widely sold medicinal species that has been combined with other species, e.g. *Quercus rugosa* and *Crataegus pubescens* as a cough remedy (cf. INI 1995). Other combinations from the list of 152 species are possible but should be evaluated to determine whether a market exists.

CONCLUDING REMARKS

Recommendations offered to the *ejido* of El Terrero focus on a few selected products available from local forests whose importance is already recognized by community members. Our suggestions attempt to integrate existing patterns of use with a more focussed and systematic commercialization of timber and nontimber forest products into the *ejido*'s forest management plan. Benefits derived from these recommendations will be available first to members of the community; thus investments made by the *ejido* itself to evaluate the potential of certain resources in greater detail, e.g. nutritional quality or pharmaceutical activity of certain species, will confer benefits over the long-term directly to the community. Decisions to implement these recommendations will be a function of the *ejido*'s own understanding of potential costs and benefits. The ethnobotanist's input in helping the *ejido* to understand these costs and benefits is crucial because both social and economic impacts of implementing these recommendations require both the perspective of the community and an independent ecological and economic assessment on the part of the researcher. Loss of biodiversity through inappropriate use of natural resources might not be readily apparent to community members but its impact will be felt globally. Recommendations for use of forest resources need to be evaluated periodically to ensure that benefits to community and environment outweigh their costs. Ethnobotanical work in the *ejido* of El Terrero is only beginning. We now need to follow up on the community's evaluation and implementation of our recommendations and those made on the remaining 127 species of plants that the community recognizes as useful.

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HYBRIDIZATION IN TWO DISTANTLY
RELATED MEXICAN BLACK OAKS *QUERCUS*
CONZATTII AND *QUERCUS* *EDUARDII*
(FAGACEAE: *QUERCUS*: SECTION *LOBATAE*)

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ABSTRACT

Populations of hybrids of distantly related black oaks (Fagaceae: *Quercus*: section *Lobatae*), *Quercus conzattii* Trelease and *Quercus eduardii* Trelease, are examined throughout the southern Sierra Madre Occidental of Mexico, where the distributions of the two parental species overlap. Morphometric analyses are presented to show the structure of a hybrid swarm relative to that of populations where extensive hybridization is not apparent. A major swarm south of Cd. Durango shows 82% *Q. conzattii*, 14% intermediate plants, and 4% *Q. eduardii* distributed unevenly within the site. Parental types are differentiated by leaf size, density of pubescence of the abaxial surface, rugosity of the adaxial leaf surface, reticulation of the adaxial leaf surface, cordateness of the leaves, leaf shape, and other characters. Hybrids were morphologically intermediate. Acorn production in all types is good, and in a very limited sample there is no indication of reduced pollen fertility. Anderson hybrid index histograms show continuous morphological variation at the hybrid swarm site and limited variation, representative of parental types, at other sites. Cluster analysis of populations yielded unexpected grouping of a *Q. conzattii* population with the adjacent hybrid swarm population. Discriminant function analysis explained the clustering pattern by grouping several immature plants and several weakly intermediate plants with the hybrid plants. Principal components analysis also showed strong overlap between the hybrids and *Q. conzattii*. Although morphological evidence did not suggest movement of genes between species, the hybrid swarm structure suggests that potential for introgression exists.

RESUMEN

Se examinaron poblaciones de híbridos de dos especies de robles rojos (Fagaceae: *Quercus*: sección *Lobatae*) en sitios donde sus distribuciones se solapan, en el sur de la Sierra Madre Occidental de México. *Quercus conzattii* Trelease y *Quercus eduardii* Trelease son de grupos filogenéticos muy separados. Se presentan análisis morfométricos para mostrar la estructura de una población de híbridos, las especies parentales, y plantas intergradientes en comparación con poblaciones donde la hibridación no es aparente. La población híbrida, al sur de la Cd. de Durango, está integrada por 82% *Q. conzattii*, 14% plantas de morfología

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intermedia, y 4% *Q. eduardii* las cuales no están distribuidas uniformemente en esa localidad. Los tipos parentales están caracterizados por diferencias en el tamaño de las hojas, densidad de la pubescencia del envés, rugosidad del haz, reticulación de las nervaduras, grado en que la base está cordada, forma de las hojas, y otras características. Los híbridos resultaron intermedios en su morfología. La producción de bellotas en todos los tipos morfológicos fue amplia, y en una muestra limitada no hay indicación de reducción de la fertilidad del polen de las plantas de origen híbrido. Los histogramas de valores del índice de Anderson de los híbridos señalan una variación morfológica continua en la población híbrida y, en otros sitios, variación limitada, representativa de los tipos parentales. Los análisis de grupos (*clusters*) mostraron una agrupación de la población de *Q. conzattii* con la población de híbridos adyacente, en lugar de una agrupación con otras poblaciones de *Q. conzattii*, como se hubiera esperado. Los análisis de la función discriminante explicaron el patrón de agrupamiento conjuntamente entre varias plantas inmaduras y varias plantas con morfología intermedias con los híbridos. Los análisis de componentes principales también mostraron que las morfología de los híbridos y *Q. conzattii* solapan ampliamente. Aunque la evidencia morfológica no indicó movimiento de genes entre especies, la estructura de la población híbrida sugiere que hay potencial para la introgresión.

INTRODUCTION

In many plant groups reticulation plays an important part in the evolution of species and species complexes (V. Grant 1981). Hybridization between oak species (*Quercus* L.; Fagaceae) has considerable significance in the general interpretation of species in this genus (Burger 1975; Van Valen 1992). Clearly, hybridization between species occurs commonly in localized areas (e.g., Palmer 1948; Muller 1951; Hardin 1975), and several authors have discussed that subsequent introgression may be an important process in oak evolution (Muller 1952; Silliman & Leisner 1958; Maze 1968; Jensen & Eshbaugh 1976a, 1976b; Nason et al. 1992; Van Valen 1992; Whittemore & Schaal 1991). Hybridization in *Quercus* may also serve as an evolutionary stimulus, as suggested for other groups by Anderson and Stebbins (1954) and Stebbins (1959).

Evidence from ancient climatological data (from the Chihuahuan Desert region) suggests that much of north-central Mexico has experienced a progressively hotter, drier, moderately fluctuating climate since the Late Wisconsin-Holocene transition, about 11,000 years ago (Van Devender 1986; 1990; Van Devender, et al. 1987). Such climatic variation in North America may have stimulated cyclic hybridization as an important mechanism in North American oak micro-evolution and long-term adaptability, as Rattenbury (1962) postulated for evolution of the entire New Zealand woody flora and Gillett (1972) postulated for certain Hawaiian groups. Repeated periods of cyclic changes in the environment may select for long-lived perennials capable of cyclic hybridization, providing a means of adaptation to changing environments (Ehrendorfer 1959; Arnold 1992). This mechanism may have been especially important where diverse topography, cli-

mate, and habitat result in interfertile but more or less ecologically differentiated oak species occurring in sympatry. Such geological and climatic conditions occur in the mountains of Mexico, North America's center of oak diversity (Muller 1951; Nixon 1993).

Of the approximately 150 oak species in North America, about 135 (90%) occur in Mexico (Nixon 1993). Oak hybridization has been documented in the U.S. since the 1920s (Trelease 1924; Palmer 1948; V. Grant 1981). At that time it was not discussed in any of the comprehensive works of Mexico's oak flora (Standley 1920; Trelease 1924; Camus 1936–1938; 1938–1939; 1952–1954; Martínez 1951–1974; Zavala 1989) or in Mexican botany (Cerdeña 1989; González V. 1986; Bello G. & Labat 1987; González E., et al. 1991) until recently (McVaugh 1974; Boecklen & Spellenberg 1990; Spellenberg 1992, 1995). Of course, biological processes recognize no such political boundaries, and documentation and analysis of oak hybridization within a region of such great diversity is essential to understanding the evolution and speciation process of this large genus.

Among rather closely related oak species interspecific hybridization has been well documented (Stebbins, et al. 1947; Palmer 1948; Muller 1952; Cooperrider 1957; Silliman & Leisner 1958; Tucker 1959; Bray 1960; Bensen, et al. 1967; Maze 1968; Brophy & Parnell 1974; Hardin 1975; Jensen & Eshbaugh 1976a, 1976b; Rushton 1978, 1979; Jensen et al. 1984; Arnold 1990; Arnold 1992; Elenarossello et al. 1992; Whittemore & Schaal 1991; Nason et al. 1992). In few instances it has been reported and explored in distantly related taxa (e.g., Tucker 1961; Boecklen & Spellenberg 1990).

Quercus conzattii Trelease and *Q. eduardii* Trelease, which we have found to be hybridizing in the southern Sierra Madre Occidental of Mexico, are morphologically quite distinct and considered to be phylogenetically distant. Trelease (1924) placed them in separate groups, the Racemiflorae and Durifolae, respectively. He considered these groups to be part of the same phylogenetic lineage for which the Durifolae is basal and the Racemiflorae is derived (for an early hypothetical phylogeny see Trelease 1924, p. 20). Camus (1952–1954) was unsure of the correct subsectional placement of *Q. eduardii* (informally allying it with the subsections Durifolae and Agrifoleae). However she, and later Martínez (1954, 1955, 1959), in their necessarily linear presentations, treated these species as rather distantly related taxa.

We discovered *Quercus conzattii* to have a bicentric distribution, with southern populations occurring in Oaxaca and northern populations occurring in southern Durango, northern Jalisco, Nayarit, and adjacent parts of Zacatecas (specimen citations are in Spellenberg & Bacon 1996). In Durango,

Q. konzattii occurs in semi-xeric oak forest to xeric savanna-like sites, where it generally thrives in slightly more protected, rockier sites than *Q. eduardii* at elevations 1,650 to 2,040 m above sea level. At its lowest elevations it occurs on north-facing canyon sides, occasionally appearing on flat, more xeric areas just above such sites. Low elevation sites are open, and due to their accessibility, often highly disturbed.

Quercus eduardii inhabits sites that although rocky seem to have a high proportion of fine particles in the soil. It extends from central Durango to Querétaro and south to southwestern and south-central Jalisco. In Durango *Q. eduardii* occurs from 1,850 to 2,600 m above sea level, extending continuously from the upper limits of grassland to the lower limits of the mesic pine-oak forest. In low, comparatively xeric savannas it occurs with *Quercus chihuahuensis* Trel., *Bursera* sp., *Dodonaea viscosa* Jacq., *Opuntia* spp., *Agave* spp., and *Dasyllirion* sp. In low elevation forest it occurs with *Arctostaphylos pungens* H. B. K., *Pinus* spp., and *Quercus durifolia* Seeman. *Pinus cembroides* Zucc. and *Juniperus* spp. are common associates between the extremes in habitats. In open habitat on rolling hills it often occurs on the exposed areas immediately above *Q. konzattii* populations.

Our investigation of hybridization between these taxa began with a series of specimens collected under the number *Spellenberg & González 10266* (specimen numbers explained in Appendix) collected in July of 1990 on the southern slopes of the Valle de Guadiana, near Ferrería south of Cd. Durango, Durango, Mexico (Fig. 1). They were first misidentified as oaks belonging to other distantly related species, *Q. sideroxyla* Humb. & Bonpl. and *Quercus crassifolia* Humb. & Bonpl. Plants of the collection exhibited great variation (as in Fig. 2) and later were determined to be intermediate between the two very different black oak species also present at the site, *Q. konzattii* (previously unknown from the region) and *Q. eduardii*.

This study aims to document and analyze a hybrid swarm and other sites with little hybridization involving these two very distantly related and morphologically distinct black oak species, *Q. konzattii* and *Q. eduardii*, in the southern Sierra Madre Occidental of Mexico (Fig. 1). The principal study site is located on the northern edge of the distribution of *Q. konzattii*, where the long-term environmental fluctuations may have been the greatest in the species' range.

HYBRID SWARM SITE LOCATION AND GENERAL STRUCTURE

At the hybrid swarm site, the presence of hybrids was evident due to morphological intermediacy and variability of plants. Linear transects were established every 10 m perpendicular to the longest axis of the hybrid swarm. The dimensions of the main axis and the 13 linear transects extending

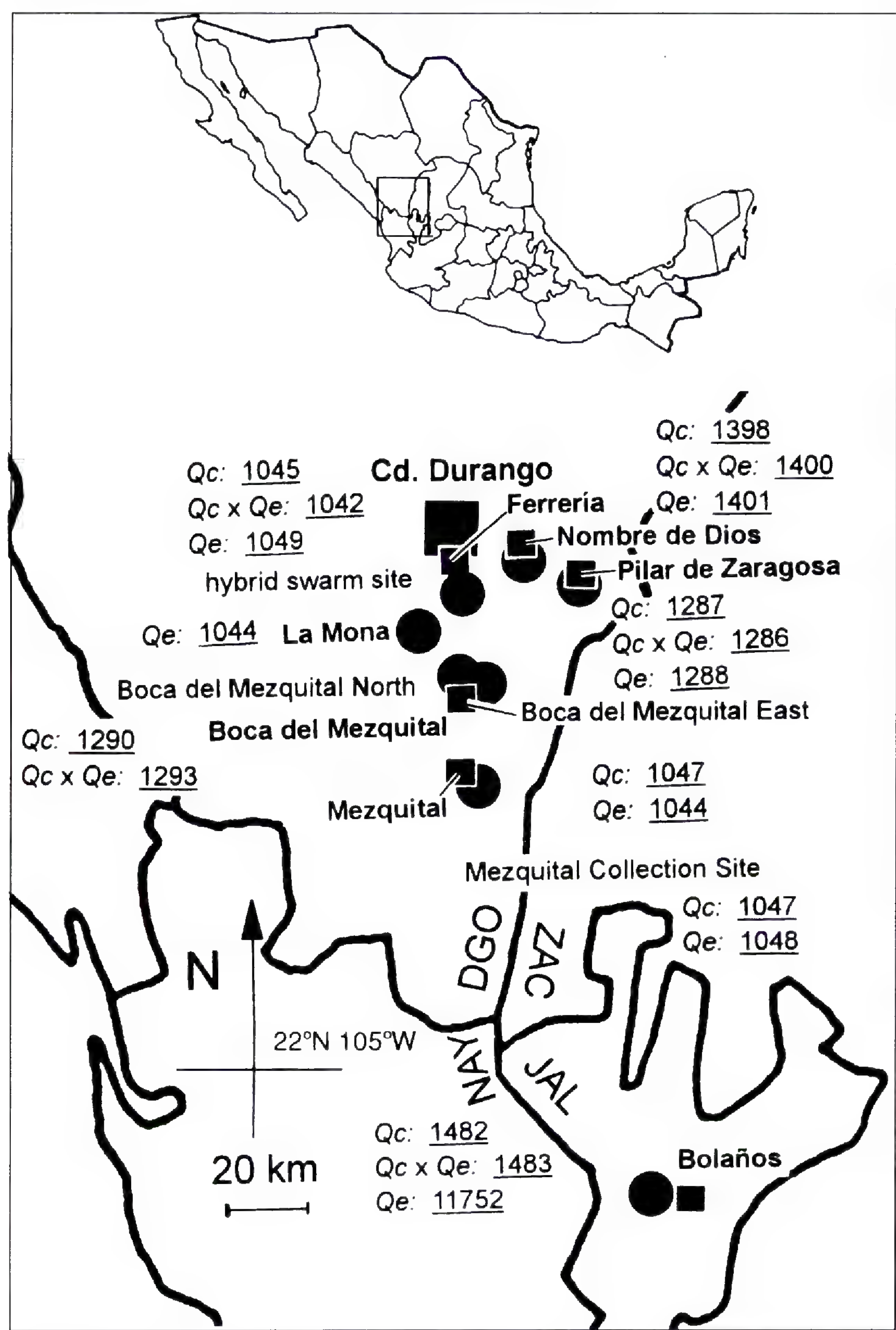


FIG. 1. General location of collection sites (circles with collection numbers, as explained in appendix) in south-central Durango and northern Jalisco, Mexico, showing known locations of *Q. conzattii* × *Q. eduardii*.

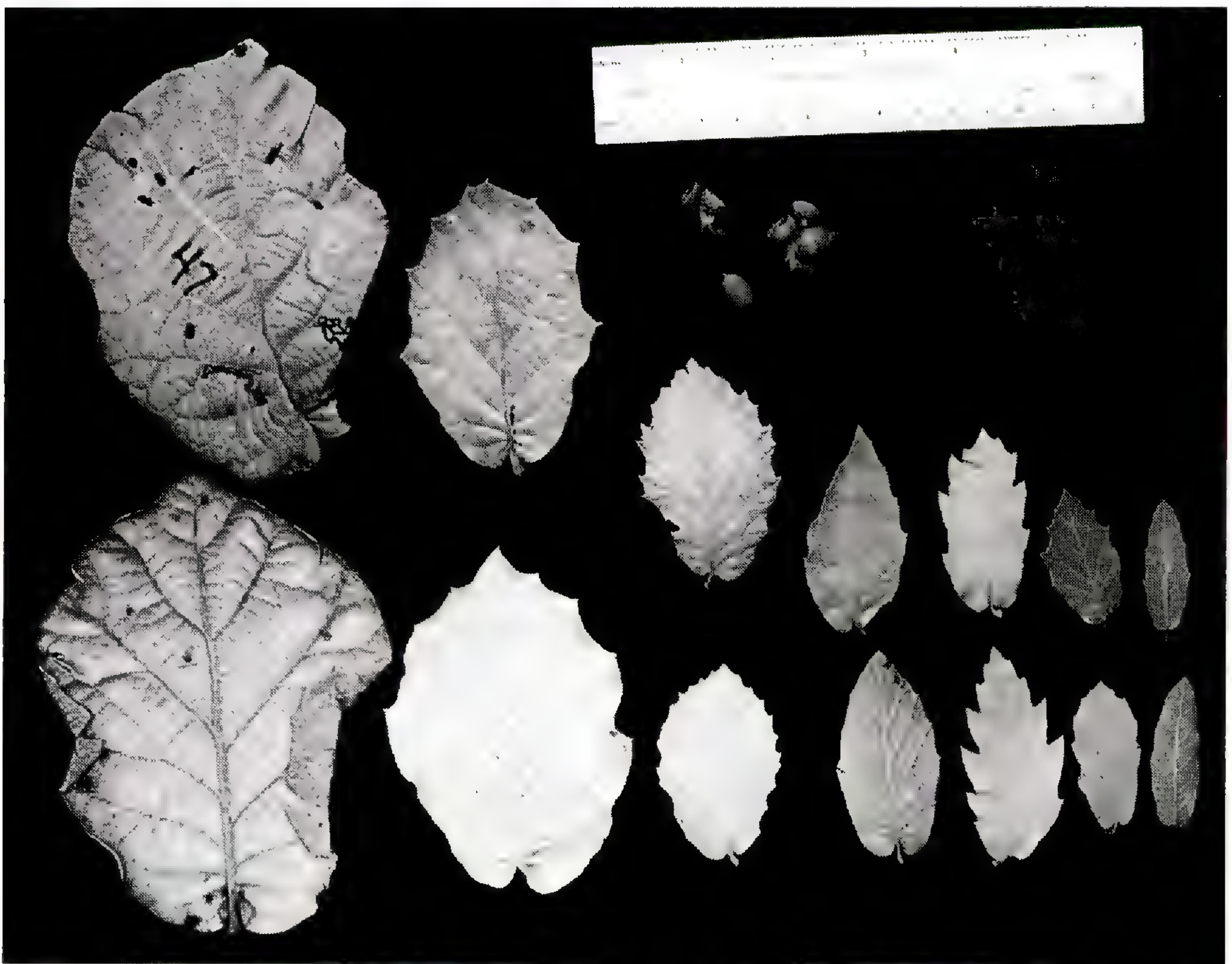


FIG. 2. Variation in adaxial (upper series) and abaxial (lower series) leaf morphology exhibited by leaf pairs from plants from the Ferrería hybrid swarm site and examples of peduncles and acorns from *Q. conzattii* (left) (1475) and *Q. eduardii* (Spellenberg and Bacon 11692). Leaves vary from *Q. conzattii* (1045–47), various intermediate types (from left to right, 1042–9, -5, -1, -7, -8), to *Q. eduardii* (1044–26).

from it were defined by the limits of the population of individuals expressing characteristics considered to be diagnostic of *Q. conzattii*, with transects ending where the black oak population consisted of only *Q. eduardii*. The population was 1,200 m long on the ca. N-S axis and 560 m wide on the ca. E-W axis. The position and identification of all black oaks whose crowns occurred within 1 m of the transects were recorded in the field.

This hybrid swarm near Ferreria is physiographically bound on its east, north, and west edges by relatively steep slopes, the upper reaches of which correspond to the population boundaries. These slopes limit the population to a relatively narrow area just above a shrubby grassland at the lower edge of the oak zone. From these boundaries the site slopes gently to the west and, farther south, rises slightly into a barren flat and, beyond, a small hill. Moving south from the site's north edge, dominants change from primarily *Q. conzattii* to more hybrids, and *Q. eduardii* (Fig. 3), and white oaks allied to *Q. grisea* Liebm. Within the transect area, plants with similar morphologies appear somewhat clumped together but this was not statis-

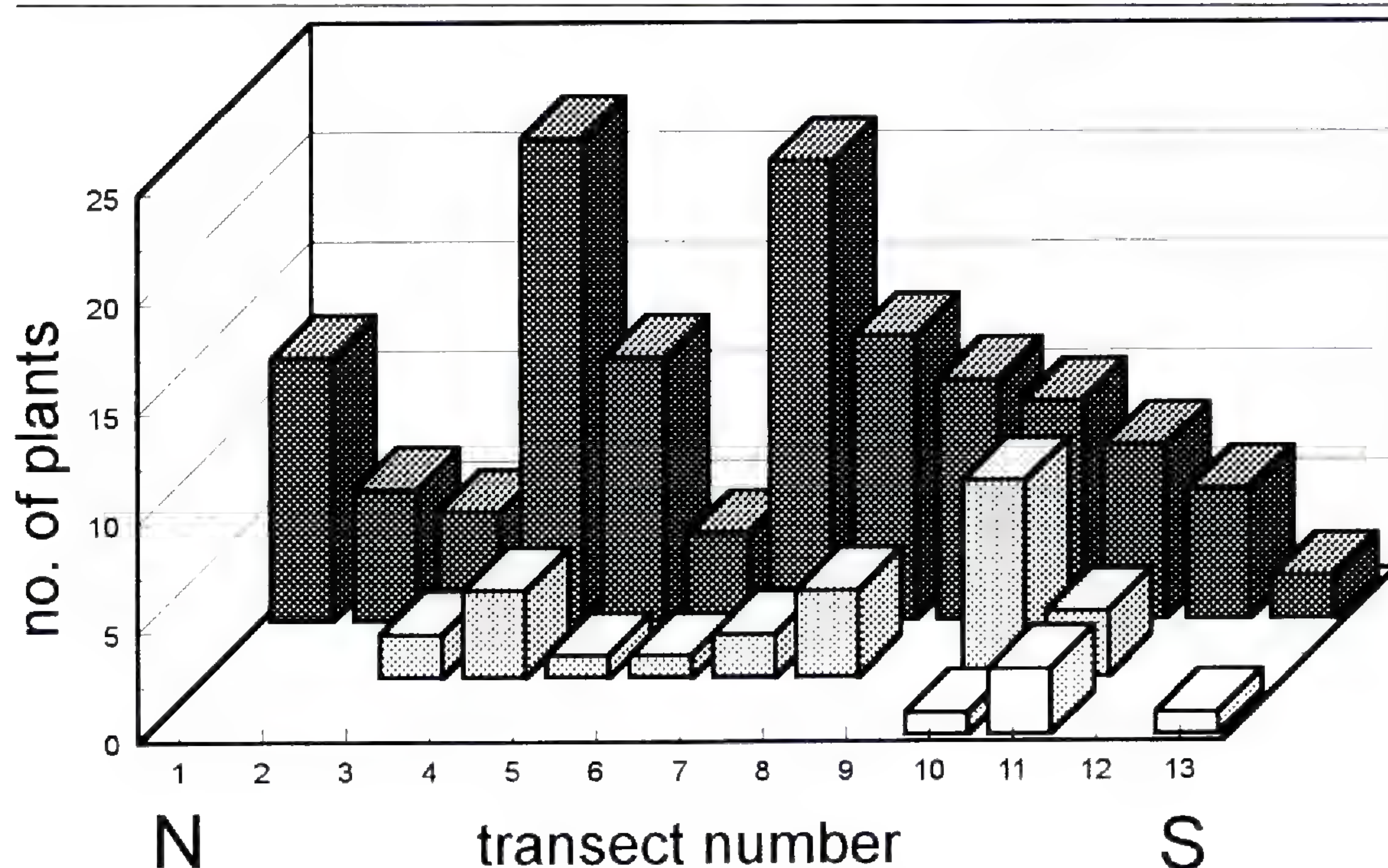


FIG. 3. Distribution of black oak taxa on linear transects at Ferrería. With histogram bars representing (front to back) *Q. eduardii*, individuals of hybrid origin, and *Q. conzattii*, respectively. Transect 1 is northernmost and transect 13 is southernmost. Transects are oriented approximately E-W.

tically verifiable. Beyond the southernmost transect no *Q. conzattii* and only an isolated hybrid individual were present.

On the transects we found 163 black oaks (Fig. 3). Putative F_1 and later generation individuals were distributed unevenly throughout the site except on the south end, where only *Q. eduardii* occurred. *Q. conzattii* is the most abundant black oak in the hybrid swarm area, represented by 82% ($n = 133$) of the individuals. Hybrids made up 14% of the population ($n = 25$), and, among these, only 4% ($n = 7$) of the total number of black oaks sampled were probable F_1 plants (morphologically intermediate without apparent recombination of characters). The frequency of later generation hybrids (non- F_1) was equal (5.5% each) for *Q. conzattii*-like hybrids ($n = 9$) and *Q. eduardii*-like hybrids ($n = 9$). Three percent ($n = 5$) of the black oaks within the hybrid zone were considered relatively pure *Q. eduardii*. The relatively small percentage of hybrid individuals recorded becomes more impressive when one considers the extended population of *Q. eduardii* to the south. This suggests that post-zygotic selection resulting from subtle differentiation of habitat is probably a key factor isolating these species, as Muller (1952) proposed in his evaluation of several hybridizing oak species pairs. The distribution of *Q. eduardii* almost exclusively at the south end of the site and the lack of *Q. conzattii* and hybrids beyond the southernmost transect indicates that such ecological isolation is occurring at Ferrería.

TABLE 1. Characters used in calculation of Anderson hybrid index values and descriptions of states considered "typical" for each taxon evaluated. Anderson hybrid index values for each taxon are indicated in parentheses below each taxon name.

character	<i>Quercus konzattii</i> (2)	hybrids (1)	<i>Quercus eduardii</i> (0)
leaf size (length in mm)	≥ 98	58–98	≤ 58
leaf shape (length:width)	≤ 2.1	2.1–3.1	≥ 3.1
rugosity of leaves	veins strongly impressed	veins moderately impressed	veins not impressed
luster of adaxial leaf surface	dull	mod. lustrous	lustrous
pubescence type on adaxial surface	woolly & dense	moderately woolly & dense	short & sparse
pubescence type in leaf vein axils	no dense clusters	dense clusters barely visible	dense clusters
papillae on abaxial epidermis	present	barely visible	absent
prominence of reticulation of leaf veins	strongly prominent	some reticulation	absent
bullateness of abaxial epidermis	strongly bullate	mod. bullate	smooth

SALIENT CHARACTERS OF PARENTS AND HYBRIDS

In this section and following, specimens are cited by collection number, fully documented and explained in the appendix. Collection numbers are those of Bacon and associates unless otherwise indicated.

Quercus konzattii:—Shrubs to trees; leaves thick and very stiff, to 14 cm long, strongly convex (often folding when pressed), broadly obovate to round; adaxial surface olive green, semi-lustrous to dull, nearly glabrous, rugose by impression of larger veins and veinlets; abaxial surface gray (in Durango), pilose, the pubescence of long-stipitate-fasciculate trichomes (terminology of Hardin 1979) with stipes 1–1.2 mm bearing 6–7 branches to 1 mm long, nearly or completely obscuring the strongly bullate, minutely papillate epidermis, abaxial vein axils without marked differentiation of trichomes; acorns small, in groups of 1 or 2 and nearly sessile or, usually, up to 4–5 on short peduncles 1–1.5 cm long, maturing in late summer or early fall. General characters of the leaves and trichomes of *Q. konzattii* are evident in Figs. 2 and 4C, respectively, and qualitative and quantitative characters of plants examined are summarized in Tables 1 and 2.

Quercus konzattii × Quercus eduardii F₁ and segregates:—Hybrid plants are intermediate between the parental species in leaf morphology (size, shape, texture, bullateness, convexity, adaxial luster, vein reticulation,

TABLE 2. Characters used in multivariate analyses. All variables were used in analyses involving the Full Data Set. Annotations: 1 = data used in Abbreviated Data Set; 2 = no significant difference in Full Data Set; 3 = no significant difference in Abbreviated Data Set; and 4 = data used in Hair Data Set (see text for explanation of data sets).

variable (units)	<i>Quercus conzattii</i> mean (s.d.)	hybrids mean (s.d.)	<i>Quercus eduardii</i> mean (s.d.)
leaf length (mm) ¹	80.3(12.3)	68.8(21.8)	35.4(6.3)
maximum leaf width (mm) ¹	54.5(9.0)	37.6(15.9)	12.2(2.3)
dist. from apex to pnt on midrib that corresponds to widest pnt on leaf (mm) ¹	33.4(9.6)	32.5(10.1)	17.0(5.4)
leaf width at basal 1/3 of leaf (mm)	46.5(10.4)	32.7(13.9)	11.1(2.1)
leaf width at apical 1/3 of leaf (mm)	50.4(7.4)	33.4(16.0)	10.6(2.2)
no. veins per leaf ²	17.3(2.1)	18.2(3.0)	16.2(2.9)
no. teeth per 3 leaves	37.8(11.9)	28.2(14.2)	16.3(11.6)
width of midvein adaxally (mm) ¹	2.0(0.6)	1.8(0.6)	1.2(0.3)
width of midvein abaxally (mm) ¹	5.2(1.2)	4.0(1.4)	2.1(0.4)
% coverage by pubescence of abaxial leaf surface ¹	98.4(2.7)	88.8(15.8)	66.3(24.6)
% coverage by pubescence of adaxial leaf surface ^{1,3}	5.9(17.8)	22.8(33.6)	32.4(40.6)
% coverage by pubescence of first year stem	100(0)	100(0)	100(0)
maximum tooth ht. on leaf (mm) ¹	1.0(0.4)	0.8(0.4)	0.5(0.4)
leaf apicule length (mm)	0.6(0.4)	0.5(0.4)	0.4(0.2)
petiole length (mm)	5.4(2.8)	4.2(1.7)	2.9(1.0)
leaf surface rugosity (%)	18.8(19.0)	12.4(19.0)	4.1(15.8)
twig diameter (mm)	2.2(0.41)	2.7(2.27)	1.2(0.38)
petiole diameter (mm)	5.7(1.86)	3.7(1.54)	2.5(0.58)
cordateness of leaf base (mm)	2.2(1.41)	0.7(0.66)	0.2(0.28)
vein angle at midleaf (degrees) ²	137.7(8.8)	143.4(8.5)	127.7(27.7)
leaf apex angle (degrees)	112.2(25.6)	79.6(17.3)	75.7(23.4)
stipe length of trichomes of abaxial leaf surface (mm) ⁴	0.096(0.016)	0.058(0.024)	0.005(0.008)
maximum branch length of trichomes of abaxial leaf surface (mm) ⁴	1.01(0.143)	0.64(0.248)	0.029(0.007)
number of branches of trichomes of abaxial leaf surface ⁴	6.6(0.8)	9.8(4.0)	15.5(2.7)

density of abaxial pubescence, and length of abaxial trichomes [Fig. 4]), and other intermediate characters (see data analyses below). Later generation segregates or backcrosses vary continuously from more or less exact intermediacy to one or the other parents (Fig. 2 and Tables 1 and 2).

Hybrid individuals (see appendix) were found in nearly all locations where *Q. conzattii* and *Q. eduardii* intermixed (Fig. 1). Hybrids were also found in areas where both species were not intermediately intermixed, but where the second putative parent occurs within 0.5–2 km. Such was the case north of Boca del Mezquital, where both *Q. conzattii* (1290) and

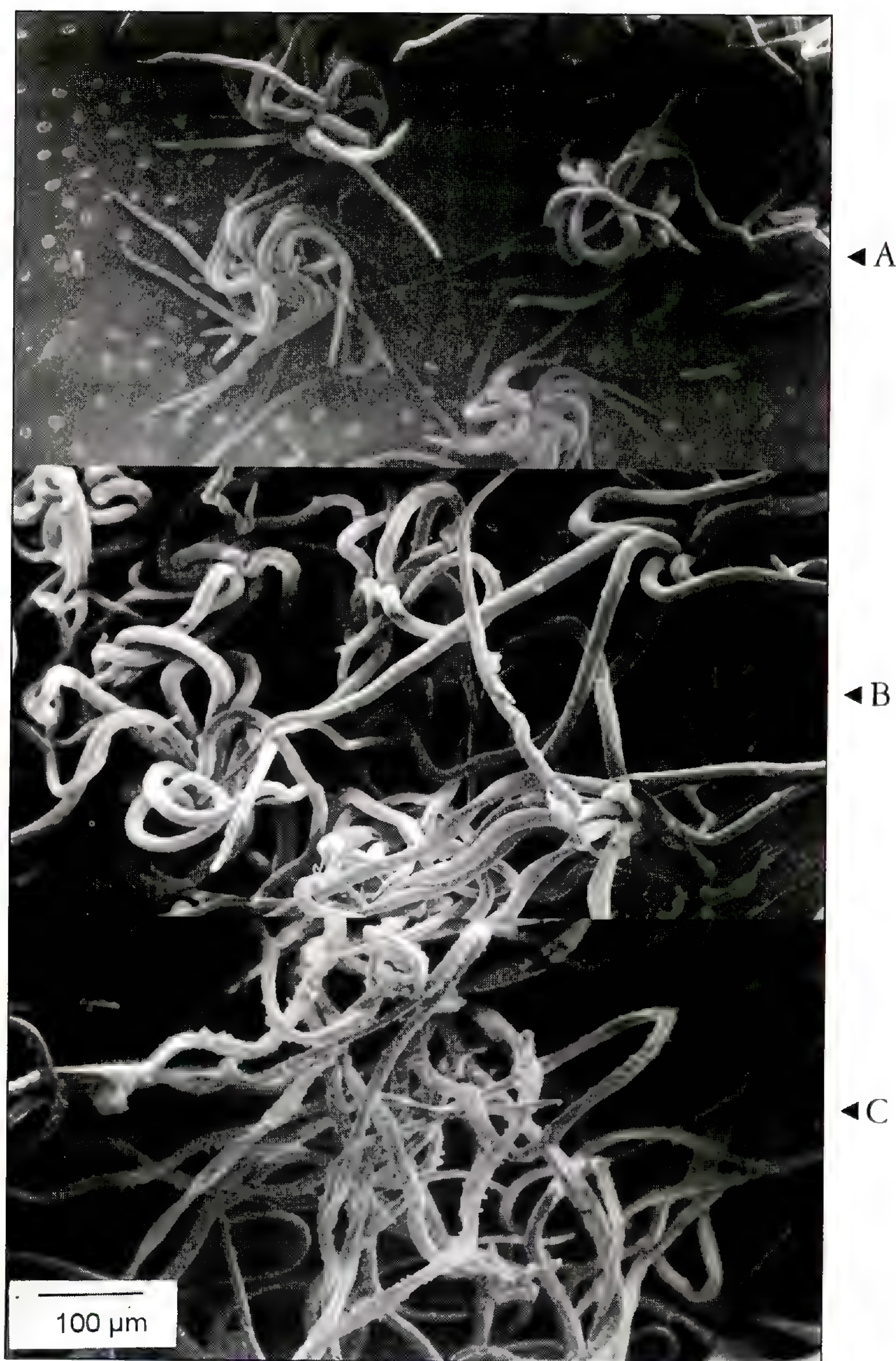


FIG. 4, 4C. details of abaxial trichomes on a leaf of *Q. eduardii* (Spellenberg 10974–12); note that dense, tangled branches obscure epidermis and the presence of a long stipe at top, right center. 4B. details of abaxial trichomes on a leaf of a hybrid with *Q. eduardii*-like morphology (Spellenberg, *et al.* 10971–9); note partial visibility of epidermis and presence of short stipes (trichome at top center and at bottom right). 4A. details of abaxial trichomes on a leaf of *Q. conzattii* (Spellenberg 10973–12); note visibility of epidermis and sessile nature of rosulate trichomes.

intermediate individuals (1293) occurred, and *Q. eduardii* (1048) occurred on nearby (1 km) hills and arroyos.

Quercus eduardii:—Shrubs to trees; leaves to 5.2 cm long, thin and stiff, but flexible, flat, oblong, the adaxial surface dark green, lustrous, nearly glabrous; abaxial surface light green, sparsely pubescent, the pubescence of rosulate trichomes (terminology of Hardin 1979) with stipes 0.05–0.15 mm bearing 15–16 contorted or sinuous branches 0.32–0.34 mm long, not obscuring the smooth epidermis (Fig. 4A), the vein axils with clusters of dense, stout, conspicuously stipitate, sinuously-branched hairs; acorns small, in groups of 2–3 on a slender peduncle 0.5–2 mm long, maturing in mid- to late summer. Acorns and general leaf characters are visible in Fig. 2.

ANALYSIS OF POPULATIONS OF PARENTAL SPECIES AND HYBRIDS

We collected from sites where intergradation was obvious and from other sites where each of the parental species was away from genetic influence of the other. At four sites (exact localities and specimens cited in appendix and illustrated in Fig. 1) the following situations were found. Material from 93 plants was collected, pressed, dried, and later measured:

- 1) *Q. conzattii* and *Q. eduardii* hybridizing extensively south of Ferrería, represented by collection of:
 - a) 18-intermediate specimens (1042-[1–18 (see Appendix for explanation of specimen numbering)]),
 - b) 19-*Q. eduardii* specimens (1044-[1–19]), and
 - c) 18-*Q. conzattii* specimens (1045-[1–18]);
- 2) *Q. eduardii* away from any other black oak at La Mona represented by collection of 11 specimens (1049-[1–11]),
- 3) *Q. conzattii* away from any other black oak (the nearest plant of *Q. eduardii* found more than 500 m from the population) east of the village of Boca del Mezquital represented by collection of 10 specimens (1046-[1–10]), and
- 4) both parental species with very limited hybridization at Mezquital (at first we thought none; after several visits to the site a single, small intermediate individual was discovered [Spellenberg & Bacon 11681] that was not used in analyses) represented by collection of nine *Q. conzattii* specimens (1047-[1–9]) and eight *Q. eduardii* specimens (1048-[1–8]).

Further investigation revealed that hybridization between these species was widespread but sporadic in this region, but only at one site (Ferrería [1042]) did the situation represent a hybrid swarm with many individuals forming morphological continuum between parental species. Hybrid populations were documented at a number of other locations in southern Durango (1286, 1400, 1293, 1042, Spellenberg & Bacon 11681), and a single hybrid individual (1483) was found in Jalisco (see appendix).

Vegetation at the sites varied from highly disturbed, arid savanna (lower elevational extreme of "bosque de coníferas y de *Quercus*" of Rzedowski 1978) at the hybrid swarm site near the agricultural village of Ferrería, to mature *Quercus-Pinus-Arctostaphylos* woodland at Mezquital. Vegetation at La Mona was *Quercus-Pinus* forest. Vegetation at Boca del Mezquital was *Quercus* savanna, where *Q. conzattii* occurred high on the slope and *Q. eduardii* occurred more than 500 m away in the arroyos and on the bajadas below. Grazing and associated habitat disturbance probably occurred at all the sites, but was most likely much less on the very steep slopes of the Mezquital population.

ANDERSON HYBRID INDEX

Morphological intermediacy or a combination of suspected parental character states are good indicators of hybridization in plants (Gottlieb 1972; Phipps 1984; Wilson 1992). Data were collected from specimens from the four sites previously mentioned to verify observations of intermediacy and inquire into the intermediacy of other morphological and micromorphological characters.

In populations where hybridization is evident, the Anderson Hybrid Index (Anderson 1949; 1953) is useful for identifying intermediate individuals (Davis & Heywood 1963), showing backcrossing (or later generation segregation), and showing the structure of a hybrid swarm (Wilson 1992). This technique is the most effective non-multivariate method for separating the parental taxa in a situation involving comparison of putative hybrid taxa (Namkoong 1966; Wilson 1992), and the histogram it yields provides the advantage of an easily assimilated graphic representation of the variation within each of the populations (Wilson 1992).

For each plant specimen from the four study sites, an Anderson hybrid index value was calculated based upon nine characters that were consistently different between the two parental species (Table 1). These data consisted of measurements or subjective evaluations that placed each character into a ranking system (Anderson 1949, 1953), based upon its similarity of a single specimen to the character condition in the parental species. Characters representative of *Q. conzattii* received a rank of 2; characters representative of *Q. eduardii* received a rank of 0; and characters that appeared intermediate between the two taxa received a rank of 1. Ranking method followed that of Wilson (1992).

The Anderson hybrid index histogram for the Ferrería population reveals a more or less continuous distribution of individuals between hybrid index values ranging from 0–17 (Fig. 5), suggesting that the black oak population there is the product of hybridization and subsequent backcrossing involving *Q. conzattii* and *Q. eduardii* and/or later generation segrega-

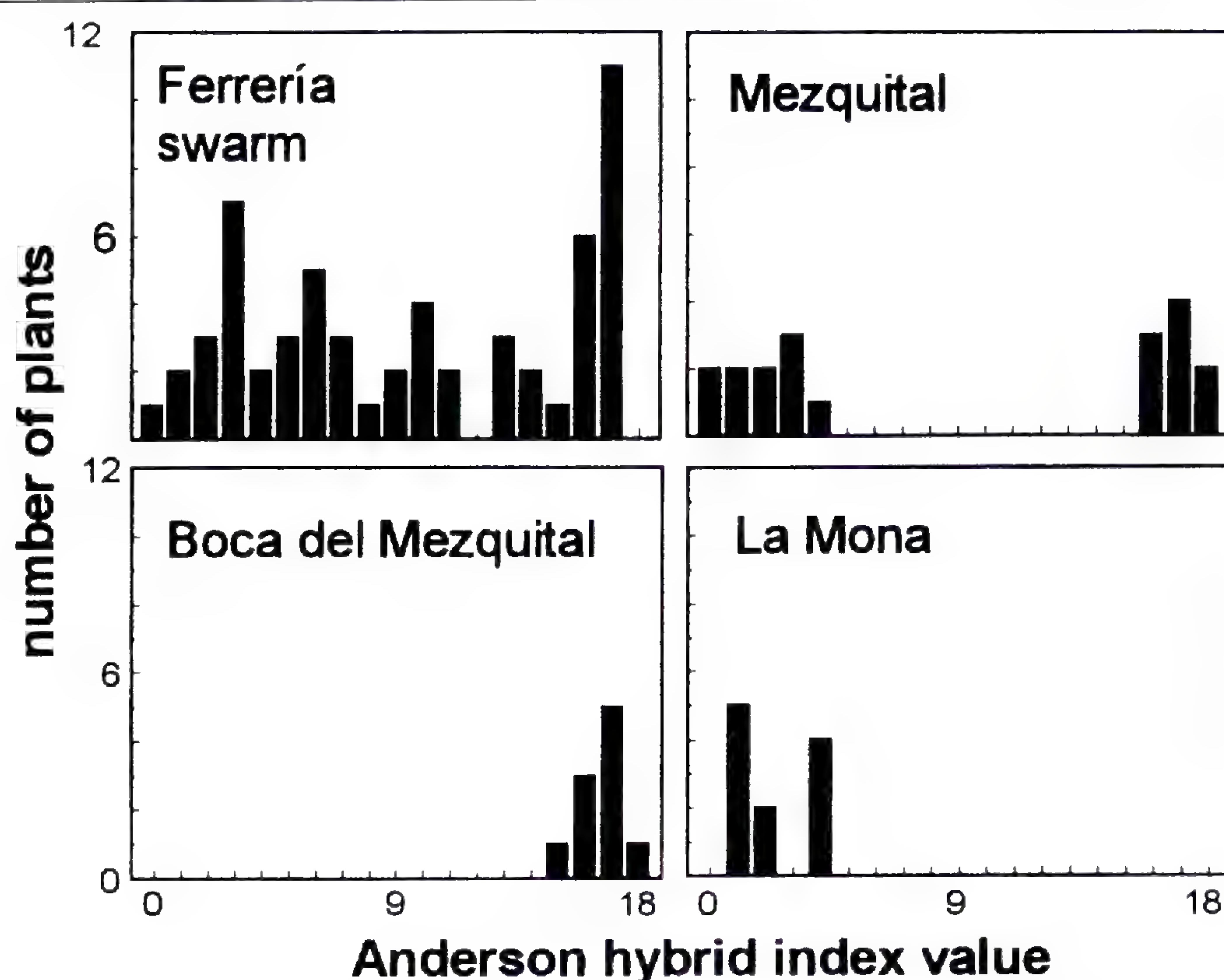


FIG. 5. Anderson hybrid index histograms showing frequencies of index values at four study sites in southern Durango. Plants of *Q. eduardii* have low values (ca. 0–4), and plants of *Q. konzattii* have high values (ca. 15–18). Intermediate values represent hybrids, backcrosses, or later generation segregates.

tion. This range of variation is similar to variation in other oak hybrid swarms thought have structure which permits introgression (Stebbins et al. 1947; Cooperrider 1957; Silliman & Leisner 1958; Bensen et al. 1967; Maze 1968; Hardin 1975). No other black oaks are at this site; a white oak, *Q. chihuahuensis* is infrequent.

The histogram for Mezquital reveals a similar range of values (1–18) but is bimodal, with perfectly intermediate plants missing excluding one weak putative F_1 discovered too late to be included in same-year collections, as mentioned above). The population east of the village of Boca del Mezquital had values ranging only from 1 to 4, indicative of individuals exhibiting characteristics only of *Q. konzattii*. Plants from the La Mona site had values ranging from 15–18, values characteristic only of *Q. eduardii*.

To further examine variation in these populations, a multivariate analysis of variance was used to compare means between taxa within and between sites. For each collection examined, initially a single measurement of each character was taken on the largest leaf (for number of teeth, three largest leaves were used). Twenty four characters were measured (Table 2). These data are hereafter referred to as the Full Data Set.

Based upon preliminary analysis of the Full Data Set, it was apparent that the taxonomic utility of some characters was greater than that of others. Consequently, 12 of the characters that demonstrated the greatest taxonomic value (annotated with a "1" after the name of the character in Table 2) were measured on up to 14 additional leaves on each specimen (fewer were measured on the few specimens with less than 14 intact leaves). These data were combined with data from the first series of measurements for a total of up to 15 repetitions on complete specimens. This data set in multivariate analyses (described below) was referred to as the Abbreviated Data Set.

Dimensions of trichomes are variable but are commonly used as reliable indicators of taxonomic affinity of individuals. Consequently, data used to calculate means for trichome stipe length, branch length, and number of branches for the Full Data Set were used to examine micromorphometric differences between populations. This data set was referred to as the Hair Data Set.

The character "pubescence on first year stems" was excluded from analyses because it did not vary significantly from 100% coverage of the stem surface. For the rest of the data, multivariate analysis of variance (MANOVA) (SAS GLM procedure, SAS Institute 1992) revealed significant differences ($P < 0.05$) between taxa within sites and among all sites for each of the three data sets for all characters except for vein number per leaf ($P = 0.07$) and vein angle at mid-leaf ($P = 0.11$) in the Full Data Set, and adaxial pubescence ($P = 0.10$) in the Abbreviated Data Set.

Means for 20 of 21 (95%) characters (exhibiting significant differences between populations) were intermediate in plants of the hybrid swarm. The non-intermediate character "twig diameter" exhibited more variation in the hybrid swarm (mean = 26.9, sd = 22.2) than did either parental species population (*Q. conzattii* mean = 25.2, sd = 9.9; *Q. eduardii* mean = 11.6, sd = 3.8), suggesting the formation of novel genotypes, a factor thought to be important in the development of new evolutionary trajectories in hybridizing species pairs (Lewontin & Birch 1966; Arnold 1992; Grant, P.R. & B.R. Grant 1992) or in permitting acceleration along existing trajectories (Grant P.R. & B.R. Grant 1994).

CLUSTERING RELATIONSHIPS BETWEEN POPULATIONS

Utilizing the same three data sets from MANOVA, cluster analysis (SAS CLUSTER procedure, SAS Institute 1992) was used to examine the clustering relationships among *a priori* recognized taxa within sites. Centroid distances (D_C) between groups within sites were calculated and are represented in three cluster diagrams (Fig. 6). The cluster analyses were robust in joining the populations of *Q. conzattii* from east of the village of Boca del Mezquital and above Mezquital. This clustering relationship was weakest

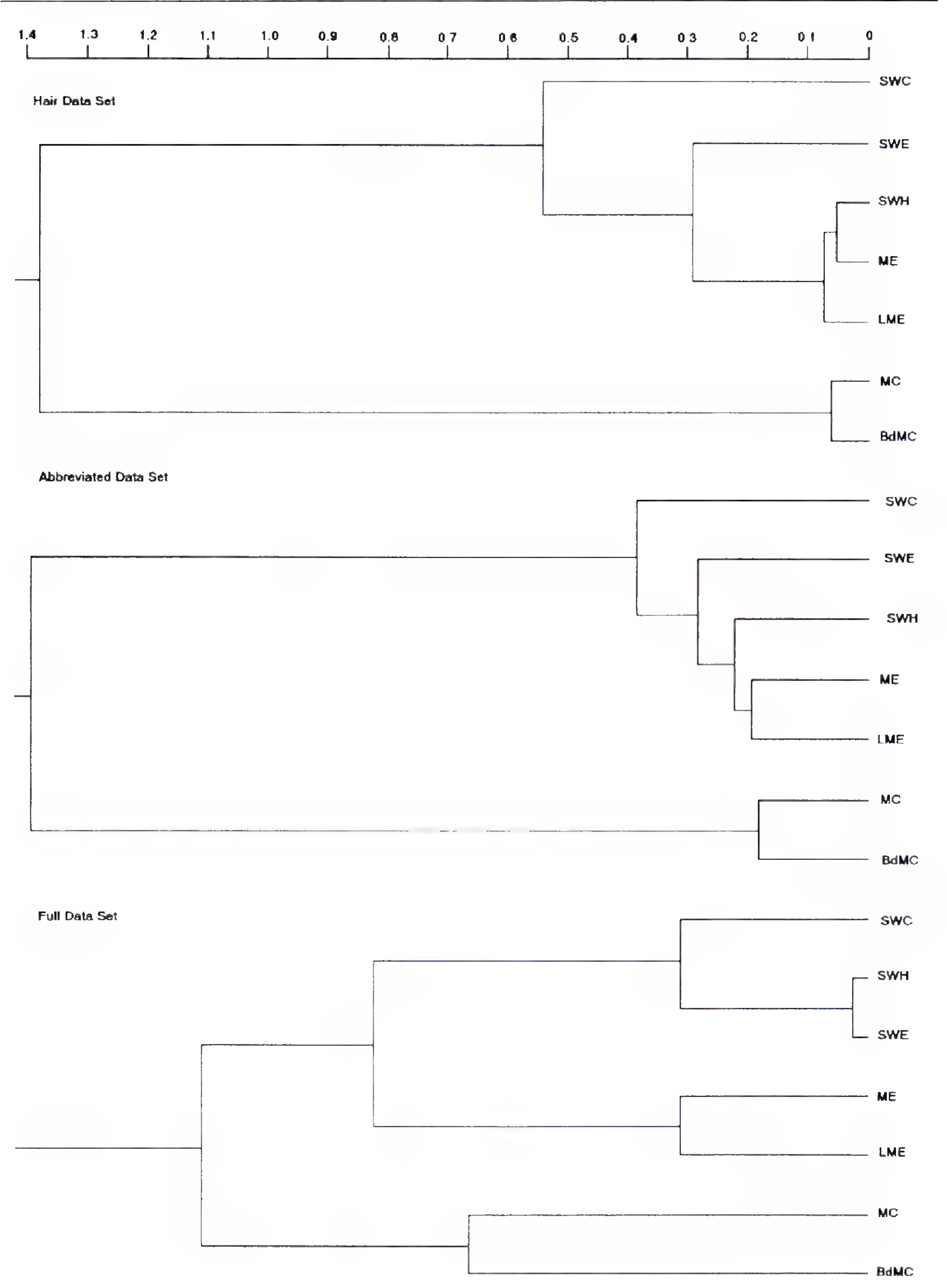


FIG. 6. Cluster diagrams showing clustering relations of *a priori* taxonomic populations at sites in southern Durango. BdMC = Boca del Mezquital (east population) (*Q. conzattii*), LME= La Mona (*Q. eduardii*), MC = Mezquital (*Q. conzattii*), ME = Mezquital (*Q. eduardii*), SWC = swarm site (*Q. conzattii*), SWE = swarm site (*Q. eduardii*), SWH = swarm site (hybrids, backcrosses, and later generation segregates).

in the Hair Data Set ($D_C = 0.05$) and strongest in the Full Data Set ($D_C = 0.82$). This cluster did not group closely with the third *Q. conzattii* population, that of the hybrid swarm site south of Ferrería. Instead, *Q. conzattii* from here clustered more closely with the cluster of *Q. eduardii* from the site and intermediate plants (Hair Data Set $D_C = 0.52$, Abbreviated Data Set $D_C = 0.37$) or with the cluster of the Ferrería hybrid and other *Q. eduardii* populations ($D_C = 0.35$).

To determine why the *Q. conzattii* population at Ferrería joined with the hybrid swarm population instead of with other *Q. conzattii* populations, populations of each taxon were compared to this *Q. conzattii* population by discriminant function analysis (SAS IML procedure, SAS Institute 1992). Five of the plants from this population were grouped with plants from the hybrid swarm (1042–41, -44, -49, -50, and -51), accounting for the unexpected clustering. The other 11 individuals grouped with individuals of *Q. conzattii* populations, as expected.

Two factors contributed to this unexpected result. First, a fire at Ferrería had set back growth of leaves on the site's north end, where *Q. conzattii* collections were made, and collections included twigs with a late-season burst of growth (1042–41, -44). Immature leaves of *Q. conzattii* tend to be small, narrow, thin, less rugose, and sparsely pubescent abaxially, and immature twigs tend to be thinner. All of these characteristics are in the direction of *Q. eduardii*. Secondly, of the remaining 16 plants identified as *Q. conzattii* at Ferrería three had small, narrow leaves and thin twigs (1042–49, -50, -51), and in these respects were more like *Q. eduardii*. One of these had relatively thin pubescence on the abaxial leaf surface (1042–50), also more like *Q. eduardii*. Otherwise, *Q. conzattii* individuals at Ferrería grouped with *Q. conzattii* from other populations of that species. The analysis indicated that an *a priori* classification was not completely correct, suggesting that these plants were of hybrid origin but were very close to *Q. conzattii*.

In the three data sets, the hybrid swarm population always joined most closely with one or more populations of *Q. eduardii* ($D_C < 0.35$ in all data sets), but the relationship between these populations was weak and variable between cluster diagrams. This suggests that hybrid plants sampled in this study are more like *Q. eduardii* than *Q. conzattii*.

Principal components analysis (PCA) is useful for the identification of individuals within a population and placement of those individuals without their *a priori* identification. PCA (StatMost PCA, DataMost 1994, 1995) of the variance/covariance matrix was performed on the Full Data Set (Fig. 7), leaving out characters whose means were not significantly different between populations (vein number per leaf, vein angle at mid-leaf, and adaxial pubescence) and character sets missing one or more data points (petiole diameter, leaf apex angle, number of teeth per three leaves, and vein angle

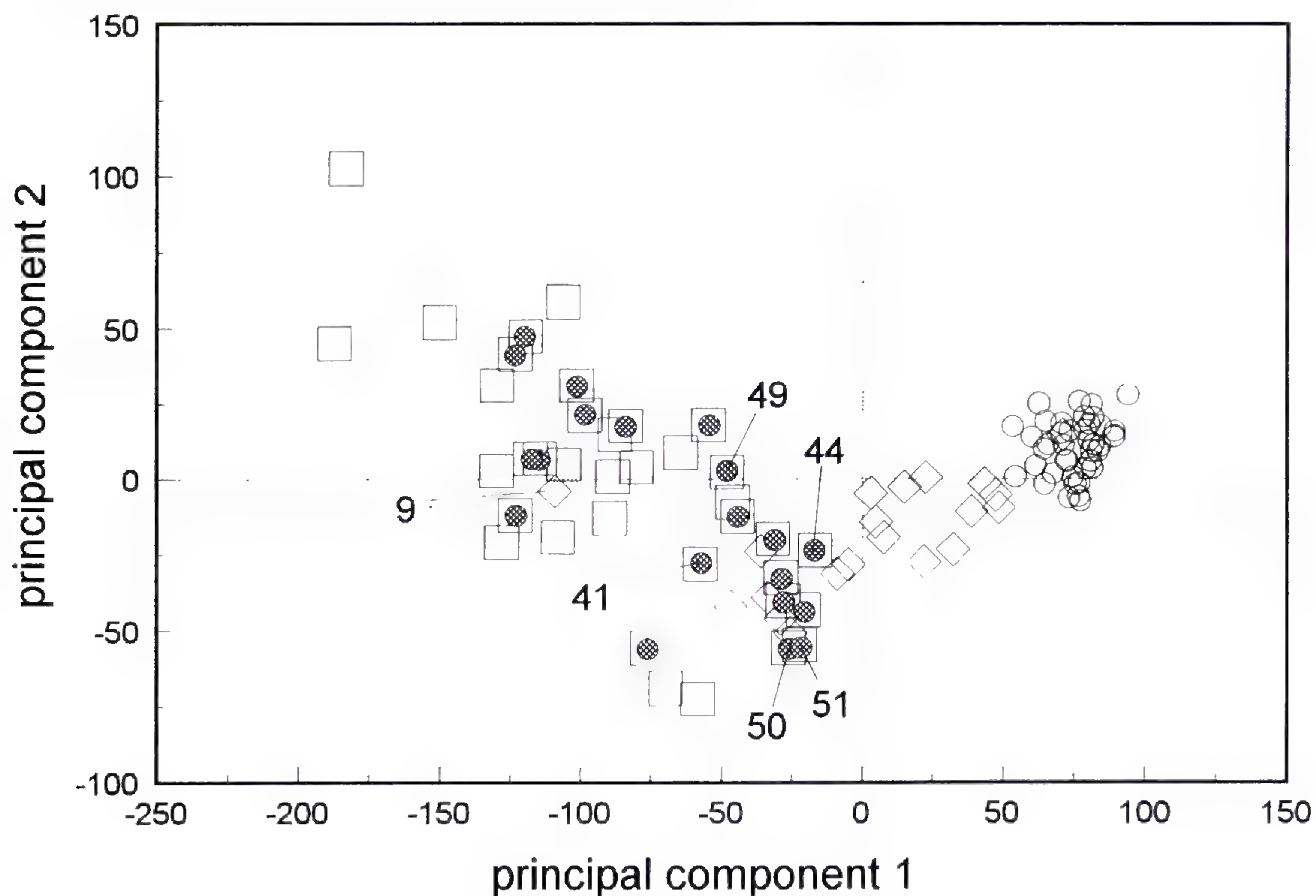


FIG. 7. Principal component plot of PC1 and PC2 of all populations sampled (1042, 1044, 1045, 1046, 1047, 1048, 1049). Loading of axes is explained in text. *A priori* identification of individual plants is represented by squares = *Q. conzattii* (filled squares from Ferrería swarm site, 1042); diamonds = hybrids, backcrosses, and later generation segregates; and circles = *Q. eduardii*. Numbers labelling points refer to specific collections (1045–41, -44, -49, -50, -51; 1042–9) referred to in the text.

at mid-leaf). Axis PC1 accounted for 71.0% of the variance, loading characters as follows: cordateness of the leaves (-0.50), trichome maximum branch length (-0.39), and leaf length (-0.35). Axis PC2 accounted for only 8.6% of the remaining variance, with cordateness (0.70), trichome maximum branch length (-0.41) and petiole length (0.32) having the greatest loading values. The two axes jointly account for 79.6% of the total variation.

The PCA plot shows *Q. eduardii* from all sites form a tight group. *Quercus conzattii*, however, is much more loosely grouped, extending from the upper left corner of the diagram to the lower center. *Quercus conzattii* plants from Mezquital fall approximately in the center of this distribution and do not extend to the extremes of distribution, as do plants from the Boca del Mezquital and Ferrería sites. The points representing plants we identified (*a priori*) as hybrids are mostly between *Q. conzattii* and *Q. eduardii*, overlapping somewhat with the former. This reinforces the discriminant function analysis assignment of some plants of *Q. conzattii* to the hybrid swarm (marked 49, 50, and 51 in Fig. 7). It likewise accounts for discriminant function analysis inclusion of two plants with immature leaves (marked 41 and 44 in Fig. 7) in the hybrid swarm group. The point designated "9" on

the PCA plot represents a plant originally identified as a hybrid (second pair of leaves in Fig. 2 is from this plant), but it has large, deeply-notched, rugose, reticulate, obovate leaves, and dense abaxial pubescence, as one would expect to find on *Q. conzattii*. Data from this plant probably played a role in the clustering of *Q. conzattii* at Ferrería with the hybrid swarm, rather than with other populations of *Q. conzattii*. Even excluding these individual specimens, there still is considerable overlap between distributions of *Q. conzattii* and hybrids. This pattern, in which one species overlaps with hybrids and one does not, is similar to that found by Rushton (1978) in hybridizing *Quercus robur* L. and *Quercus petraea* (Matt.) Liebl.

EVALUATION OF FERTILE STRUCTURES

On 3 and 4 July, 1992, 63 plants were visually ranked on a scale from 1–5, based on their vegetative similarity to either *Q. conzattii* (rank 5) or *Q. eduardii* (rank 1). Intermediate individuals were ranked as three (3), and other intergrades were ranked as 2 or 4. After ranking, inflorescences on each plant were examined to determine the stage of acorn development. They were ranked from 1–5, with ranks ranging from pistillate flowers just appearing on the peduncles (1) to acorns fully mature (5). Number of acorns per peduncle were counted for each peduncle. Correlation coefficients were calculated for mean acorn maturity rank and mean number of acorns per peduncle against the initial ranking of hybridity.

Plants with *Q. conzattii*-like morphology generally had 4–5 immature acorns per peduncle in early July, and plants with *Q. eduardii*-like morphology generally had peduncles with 2–3 more mature acorns (see examples in Fig. 2). Plants with intermediate vegetative morphology exhibited intermediacy in these characteristics (3–4 acorns per peduncle). Taxonomic rank of trees was significantly correlated ($P < 0.05$) with both number of acorns per peduncle ($r = 0.62$) and stage of acorn development ($r = 0.66$). Consequently, it appears that acorn morphology and phenology correspond to vegetative morphology.

Rushton (1978, 1988) showed that morphological intermediacy is accompanied by reduced pollen viability in some plants of *Q. robur* and *Q. petraea* hybrids, and Olssen (1975) found similar results, but with relatively high pollen stainability in most F_1 hybrids. Only four plants with pollen were available to us, and two did not provide the 200 grains usually assessed. Nevertheless, pollen in each of the four specimens showed high stainability with cotton blue in lactophenol (Radford et al. 1974). The stainability in each specimen was as follows: *Q. conzattii* (González E. 5067) 98% ($n = 59$ grains); *Q. eduardii* (5056) 83% ($n = 122$ grains); *Q. conzattii*-like hybrid (5079) 97% ($N = 260$); and *Q. eduardii*-like hybrid (5081)

97% ($N = 230$). This limited sample suggests that pollen fertility in both parental species and the hybrids is high. Consequently, it appears that hybrids, backcrosses, and F_N segregates are capable of contributing pollen-mediated genes to future generations.

DISCUSSION

Examination of other populations in south-central Durango, northern Jalisco, and extreme western Zacatecas shows that hybridization is not unique to the Ferrería site. Occasional hybrids were found (sometimes only after extensive searching) where *Q. konzattii* and *Q. eduardii* occur sympatrically. Such hybridization appears to be more frequent in the relatively xeric habitat at the northern end of *Q. konzattii*'s northern distribution, such as at Pilar de Zaragoza (1286), Nombre de Dios (1400), and north of Boca del Mezquital (1293), all near the south edge of the Valle de Guadiana near Cd. Durango. Even in these places, the level of hybridization never exceeded that which we found at Ferrería (1045). Variation in the amount of hybridization in these species ranged from that found in other species pairs thought to be introgressed (Stebbins et al. 1947; Cooperrider 1957; Silliman & Leisner 1958; Bensen et al. 1967; Maze 1968; Hardin 1975), as exemplified by the Ferrería hybrid swarm (with ca. 14% plants of hybrid origin) to very little (as in the few plants found in Pilar de Zaragoza [1286], Nombre de Dios [1400], and north of Boca del Mezquital [1293]), as Dupouey (1983) found with *Q. robur* and *Q. petraea*. There are also sites where hybridization seems limited to the occurrence of probable F_1 individuals (as in Mezquital [1483] and Bolaños 11681), as Tucker and Bogert (1973) found with *Q. gambelii* Nutt. and *Q. turbinella* Greene. Significance of hybridization between *Q. konzattii* and *Q. eduardii* in this region could be better assessed if it were known whether genetic markers cross species boundaries and spread beyond where hybridization now occurs.

Several authors have pointed out the importance of ecological factors in the control of interspecific hybridization between oak species (Muller 1952; Tucker 1961; Rushton 1979). *Q. konzattii* and *Q. eduardii* appear to be separated by soil type, and perhaps slope (affecting exposure) at the margin of the range of *Q. konzattii*. *Quercus konzattii* occurs on rocky soil, and often steep slopes. *Quercus eduardii*, commonly occurs on somewhat finer soils, often in gently rolling terrain. Climatic factors may play a role in limiting (or stimulating) hybridization. In less xeric environments, farther from the northern extreme of *Q. konzattii*'s range, hybridization between the two parental species seems quite limited, as near Mezquital, Durango (1483), and near Bolaños, Jalisco (11681). Whenever we encountered a plant of hybrid origin in a mature forest where environmental conditions appeared

less extreme (in terms of aridity), it was solitary and intermediate in character to the parents, suggesting that it was an F_1 individual. Apparent backcrossed individuals were absent.

The difference between populations where only F_1 's occur and where later generation segregation occurs may relate to the degree of disturbance these sites have experienced, as suggested by Grant (1981) and Silliman and Leisner (1958). The sites near Ferrería (1042), Nombre de Dios (1400), Boca del Mezquital (northern population) (1293), and Pilar de Zaragoza (1286) all occur on rolling hills. They are also near villages, and frequent disturbances from livestock and human activities such as wood cutting and other habitat disturbances are common. *Dodonaea viscosa*, a weedy shrub of poor, disturbed soil, is abundant at all of these sites. The site at Ferrería, for example, has both open and disturbed conditions that Grant (1981) and Silliman and Leisner (1958) mentioned as important in hybrid swarm formation. It is near an area that has been utilized by humans for 3,000 years (Hendricks 1961) and is along an old road apparently many decades old.

Despite hybridization in *Q. conzattii* and *Q. eduardii*, the two species have remained morphologically distinct. As Stebbins et al. (1947) concluded for the *Q. ilicifolia* Wangenheim $\times$ *Quercus marilandica* Muench. population in the eastern United States, several isolating barriers may be operating. Just as in their example, seasonal isolation appears to be of minor importance here. Flowering time in both species is poorly documented, but our few observations indicate that they overlap (late spring, but perhaps peaking two or three weeks apart). The flush of growth that occurs after a fire also results in at least a few plants blooming after the normal blooming date, perhaps serving to reduce barriers to cross pollination. Unfortunately, there is little published information concerning the affect of fire on hybridization. High pollen stainability indicates that hybrid infertility is not an isolating factor. Neither is failure to produce acorns, but the comparative viability of embryos is not known.

The percentage of putative F_1 hybrids in the population is relatively small (4%) within the area we defined as the hybrid swarm, and even the percentage of all putative hybrids (including F_N individuals) in the population seems rather small (14%) (Fig. 3). These numbers become very much reduced if one considers the extended population of *Q. eduardii* to the south. This suggests that post-zygotic selection is probably a key isolating factor between these species.

Although introgression beyond the hybrid swarm was not detectable in the morphological characters examined in this study, the frequency of hybridization events between *Q. conzattii* and *Q. eduardii*, the extent of hybridization at Ferrería, and the continuous variation encountered there suggests that it should play a role in evolution of these species as a means of

introducing genetic diversity. This may be particularly important at the edge of the species' ecological ranges, a factor that could facilitate directional evolutionary change (P.R. Grant & B.R. Grant 1994 and references therein). Further examination of the species, by other means, could provide more insight into gene exchange between these species.

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APPENDIX

Documenting specimens. Collections, locations of samples and characteristics of oak species and hybrids in Mexico. Herbaria are abbreviated according to Holmgren et al. (1990). Specimen numbers listed are as they appear on specimen labels (e.g., *Bacon, Spellenberg, & García A 1290*), which, in the case of specimens of one or both of the authors, may include a hyphenated suffix (e.g., *Spellenberg & Bacon 10973-12*), indicating individual tree number within a collection of individuals of a population.

Quercus conzattii—MEXICO. Durango: Cerro Chiquihuitillo, 1 km S of Puerto de la Cantera and W of Pilar de Zaragoza @ Rio Santiago, 104°W, 24°N, 4 Jul 1992, *Bacon & Spellenberg 1287* (CIIDIR, NMC); ca. 28 air km E of Durango, and 2 km S of Hwy 45 near N end of 1st mountain range E of Durango, 104°24'W, 23°59'N, elev. 1860 m, 7 Jan 1993, *Bacon & Spellenberg 1397* (CAS, IBUG, INIF, NMC); 11 road km W of Nombre de Dios on Hwy 45, 104°20'W, 23°54'N, elev. 1950 m, 7 Jan 1993, *Bacon & Spellenberg 1398* (BH, CIIDIR, IEB, NMC); 2-3 km N of Boca del Mezquital, 104°30'W, 23°40'N, 5 Jul 1992, *Bacon, Spellenberg, & García-A. 1290* (CAS, CIIDIR, F, IBUG, MEXU, NMC, TEX); near km marker 12, 4.3 road km S of Ferrería along the hwy to La Flor, 104°42'W, 23°56'N, elev. 1920 m, 5 Aug 1991, *Bacon, Spellenberg, & Rodríguez-T. 1045* (CIIDIR, F, IEB, MEXU, NMC, OAX, TEX); 2 km E of the village of Boca del Mezquital, near km marker 31, along the hwy from Durango to Mezquital, 104°42'W, 23°56'N, elev. 1920 m, 5 Aug 1991, *Bacon, Spellenberg, Rodríguez-T., & García-A. 1046* (CIIDIR, IEB, MEXU, NMC, TEX,); 10 road km SE of Mezquital, 104°22'W, 23°27'N, elev. 1,860 m, 5 Aug 1991, *Bacon, Spellenberg, Rodríguez-T., & García-A. 1047* (CIIDIR, IEB, MEXU, NMC, TEX); 3 km S of Ferrería, along the road to La Flor, 104°22'W, 23°27'N, 9 Apr 1992, *González-E. 5067* (CIIDIR); ca. 2 km E of village of Boca del Mezquital, 104°26'W, 23°46'N, elev. 1950 m, 1 Nov 1992, *Spellenberg & Bacon 10973-12* (NMC). Jalisco: 9 air km NW of Bolaños in the center of the northern extension of Jalisco, 20 road km W of Bolaños on the ascent up the mountain, 103°51'W, 21°53'N, elev. 2070 m, 23 Jan 1993, *Bacon & Spellenberg 1482* (CAS, MEXU, NMC).

Quercus conzattii Trel. × *Q. eduardii* Trel.—MEXICO. Durango: Cerro Chiquihuitillo, 1 km S of Puerto de la Cantera and somewhere W of Pilar de Zaragoza at Rio Santiago, 104°W, 24°N, 4 Jul 1992, *Bacon & Spellenberg 1286* (CIIDIR, F, IBUG, IEB, INIF, NMC); 11 road km W of Nombre de

Dios on Hwy 45, 104°20'W, 23°54'N, elev. 1950 m, 7 Jan 1993, *Bacon & Spellenberg 1400* (BH, CAS, CIIDIR, IEB, MEXU, NMC, NY, RSA); 35 road km S of Cd. Durango, along the road from Durango to Mezquital, 104°30'W, 23°40'N, 5 Jul 1992, *Bacon, Spellenberg, & García-A. 1293* (CIIDIR); 4.3 road km S of Ferrería along the hwy to La Flor, near km marker 12, 104°42'W, 23°56'N, elev. 1920 m, 4 Aug 1991, *Bacon, Spellenberg, & Rodríguez-T. 1042* (CIIDIR, F, IEB, MEXU, NMC, OAX, TEX); 3 km S of Ferrería, along the road to La Flor, 104°22'W, 23°27'N, 9 Apr 1992, *González-E. 5056* (CIIDIR); 3 km S of Ferrería, along the road to La Flor, 104°22'W, 23°27'N, 9 Apr 1992, *González-E. 5079* (CIIDIR); 10 road km SE of Mezquital on road up mountain to Las Margaritas, 104°22'W, 23°27'N, elev. 1860 m, 5 Jan 1993, *Spellenberg & Bacon 11681* (NMC); ca. 9 km S of Durango along hwy to La Flor, 104°42'W, 23°56'N, elev. 1860 m, 30 Oct 1991, *Spellenberg, Boecklen, & Sooby 10971* (NMC, MEXU); ca. 10 air km S of Cd. Durango on road to La Flor, 21 Jul 1990, *Spellenberg & González 10266* (MEXU, NMC). Jalisco: 20 road km W of Bolaños up ascent to mountains toward Los Amoles, 103°51'W, 21°53'N, elev. 2070 m, 23 Jan 1993, *Bacon & Spellenberg 1483* (CAS, MEXU, NMC).

Quercus eduardii Trel.—MEXICO. Durango: Cerro Chiquihuitillo, 1 km S of Puerto de la Cantera and somewhere W of Pilar de Zaragoza at Rio Santiago, 24°N, 104°W, 4 Jul 1992, *Bacon & Spellenberg 1288* (CIIDIR, NMC); 11 road km W of Nombre de Dios on Hwy 45, 104°20'W, 23°54'N, elev. 1950 m, 7 Jan 1993, *Bacon & Spellenberg 1401* (CIIDIR, NMC); 5 road km S of Ferrería along the hwy to La Flor, near km marker 13, 104°42'W, 23°56'N, elev. 1920 m, 4 Aug 1991, *Bacon, Spellenberg, & Rodríguez-T. 1044* (CIIDIR, F, IEB, MEXU, NMC, OAX, TEX); 10 road km SE of Mezquital along the road to Las Margaritas, 104°22'W, 23°27'N, elev. 1,860 m, 5 Aug 1991, *Bacon, Spellenberg, Rodríguez-T., & García-A. 1048* (CIIDIR, IEB, MEXU, NMC, TEX); ca. 9 air km S of Durango at top of the first ascent of the road S to La Flor out of the valley where Cd. Durango is situated, 2 air km SW of Ferrería, 104°42', 23°56'N, elev. 1920 m *Spellenberg & Bacon 11692* (MEXU, NMC); 16.5 road km S of Ferrería along the road to La Flor, across the hwy from the monument known as La Mona, 104°42'W, 23°56'N, elev. 1,860 m, 6 Aug 1991, *Bacon, Spellenberg, Rodríguez-T., & García-A. 1049* (CIIDIR, IEB, MEXU, NMC, TEX); 3 km S of Ferrería, along the road to La Flor, 9 Apr 1992, *González 5081* (CIIDIR); 6 km S of Ferrería, elev. 1860 m, 2 Nov 1991, *Spellenberg, Boecklen, & Sooby 10974*, (NMC). Jalisco: ca. 21 road km NW of Bolaños on the road to Los Amoles, 103°52'W, 21°53'N, elev. 2150 m, 24 Jan 1993, *Spellenberg & Bacon 11752* (CAS, IBUG, NMC).

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BOOK NOTICES

GOODMAN, GEORGE J. and CHERYL A. LAWSON. 1995. **Retracing Major Stephen H. Long's 1820 Expedition. The Itinerary and Botany.** (ISBN 0-8061-2703-1, hbk). University of Oklahoma Press, P.O. Box 787, Norman, OK, 73070-0787. The American Exploration and Travel Series, Vol. 73. \$38.50. 366 pp.

In Part I, The Itinerary, Goodman and Lawson document the day by day account of the route and the location of each night's campsite. From the Missouri River in Nebraska near Council Bluffs through Colorado, New Mexico, Texas, and Oklahoma ending at Fort Smith, the authors traveled and retraced the route themselves noting the vegetation and land form changes during that interval.

In Part II, The Botany, the collections of Edwin James, M.D. are studied alphabetically by family and in conjunction with their own collections from the same sites. Appendix One is a list of plant names commemorating James based on collections made along the route of the expedition. Appendix Two lists the types collected by James. The remaining indices include Sources Cited, Index to Scientific Names, Index to Common Names and General Index.

This is an excellent book based on field work by the two authors over 150 years later. With the maps and selected illustrations of then and now, it shows the effects of erosion and vegetation changes over this time period. Their study of the plants and types will aid the researcher in having an analysis readily available. This is a book that should be in everyone's library.—*Wm. F. Mahler.*

WELSH, STANLEY L. 1995. **Flowers of the Canyon Country.** (ISBN 0-87480-486-8, pbk). University of Utah Press, 101 University Services Bldg., Salt Lake City, UT 84112. Photography by Bill Ratcliffe. Paperback \$15.95. 85 pp. Color photographs. Copyrights: 1971, 1977, 1986.

The canyon lands in this text refer to the Four Corners area where Arizona, Colorado, New Mexico, and Utah meet. The Foreword was written by Glen Moore, The nontechnical text was written by Welsh for Using the Book, The Canyon Country, and The Flowers sections. The photography of Bill Ratcliffe is outstanding and has been reproduced from 4.25 by 4.75 inches to more than 8.5 by 11 inches in at least one photo. Everyone should enjoy just browsing and pondering the photographs. The text of the taxa includes a lot more information than just the typical species descriptions.—*Wm.F. Mahler.*

INVASION AND SPREAD OF *COINCYA MONENSIS* (BRASSICACEAE) IN NORTH AMERICA

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ABSTRACT

Invasion and spread of the European native *Coincya monensis* (Brassicaceae) in North America are traced. In the late 1800s the species was found in the Philadelphia, Pennsylvania/Hoboken, New Jersey area on ballast, where it has not persisted. Then, in the mid and late 20th century, naturalized populations of unknown source were documented in North Carolina, Pennsylvania, New York, Michigan, and Kentucky.

RESUMEN

Se esboza la invasión y dispersión de la planta nativa de Europa *Coincya monensis* (Brassicaceae) en Norte América. A fines del siglo XX se encontró la especie en el área de Philadelphia, Pennsylvania/Hoboken, New Jersey sobre cascajos, lugar donde no ha persistido. Luego, a mediados y fines del siglo veinte, han sido documentadas poblaciones naturalizadas de origen desconocido en Carolina del Norte, Pennsylvania, New York, Michigan, y Kentucky.

INTRODUCTION

In August 1992 JWT noted an abundant, robust, showy, yellow-flowered crucifer unknown to him along interstate highway 80 in central Pennsylvania. After making a collection of the plant, he drove on, observing the plant for many more miles at the roadside.

Later, at Northern Kentucky University, work on identification of the plant was begun. That the species is not included in the standard northeastern North American manuals (Fernald 1950; Gleason & Cronquist 1963, 1991) soon became obvious. Referral to *Flora Europaea* (Tutin et al. 1964) finally brought an answer: JWT identified the plant as *Rhynchosinapis monensis* (L.) Dandy ex Clapham in Clapham, Tutin & Warburg, one of several binomials recently applied to it. Wherry et al. (1979) included it as *Rhynchosinapis cheiranthos* (Vill.) Dandy. Al-Shehbaz (1985) treated it as *Hutera cheiranthos* (Vill.) Gómez-Campo, the name under which it appears in Rhoads and Klein (1993). The second edition of *Flora Europaea* (Tutin et al. 1993) uses *Coincya monensis* (L.) Greuter & Burdet, the name determined to be correct by Leadlay and Heywood (1990). As the common name for this species we suggest and will use "coincya."

During our joint field work in Pennsylvania in 1994, we made a special effort to collect *coincya* from as many counties as possible. Then the next year RFCN and JWT separately made additional collections of the species in Pennsylvania, the state in which it appears to be most common and where it is spreading.

In this paper we trace the species' current range in North America and summarize its collection history on the continent.

MATERIALS AND METHODS

To document the history of invasion and the species' current range in North America, we requested loans of herbarium specimens of North American *Coincya* and of species under which we thought *coincya* might be filed, incorrectly identified. We also asked for loans of unidentified crucifers resembling the species (photocopies of several of our specimens of *coincya* were included with each loan request). Of the 126 United States and Canadian herbaria to which we wrote, 90 responded. Many had no specimens of the species, but overall we received 353 sheets of miscellaneous weedy, silique-bearing crucifers. Among these specimens—including sheets of *Arabis*, *Brassica*, *Erucastrum*, *Erysimum*, *Raphanus*, *Sinapis*, *Sisymbrium*, *Tropidocarpum*, and, especially, *Diplotaxis*—we located 62 sheets of *coincya* representing 22 separate collections (some were widely distributed duplicates). When to these 22 collections are added the 23 that we made, the total is 45 collections of *C. monensis* we have seen from North America (see appendix).

IDENTIFICATION, TAXONOMY, AND NOMENCLATURE

Coincya monensis is best distinguished by its combination of conspicuously glaucous and distinctively shaped leaves (Figs. 1, 2); a usually ebracteate inflorescence (occasionally an elongate, entire bract subtends the most proximal pedicel) (Fig. 3); bright yellow petals with pale brown or violet veins (the blooming season is long: late April through October); a single row of seeds in the siliques, which have clearly 3–5 veined valves and a somewhat flattened, 1–6 seeded beak (Fig. 4). The mature silique is 3.5–8.5 cm long (including the beak); the beak is 15–20 mm long and ca. 2 mm wide at its base.

Most North American botanists are certainly as unfamiliar as we were with *Coincya monensis*. In Table 1 we detail ways to separate *C. monensis* from those crucifers that superficially may resemble it in eastern North America.

Coincya belongs to the tribe Brassiceae of the Brassicaceae (Cruciferae). This tribe is characterized by fruits being usually beaked, the beak typically 1- or few-seeded, and the cotyledons being conduplicate (Al-Shehbaz 1984). The genus is included as *Hutera* in the key to southeastern United States genera of Brassicaceae (equally useful in northeastern United States)



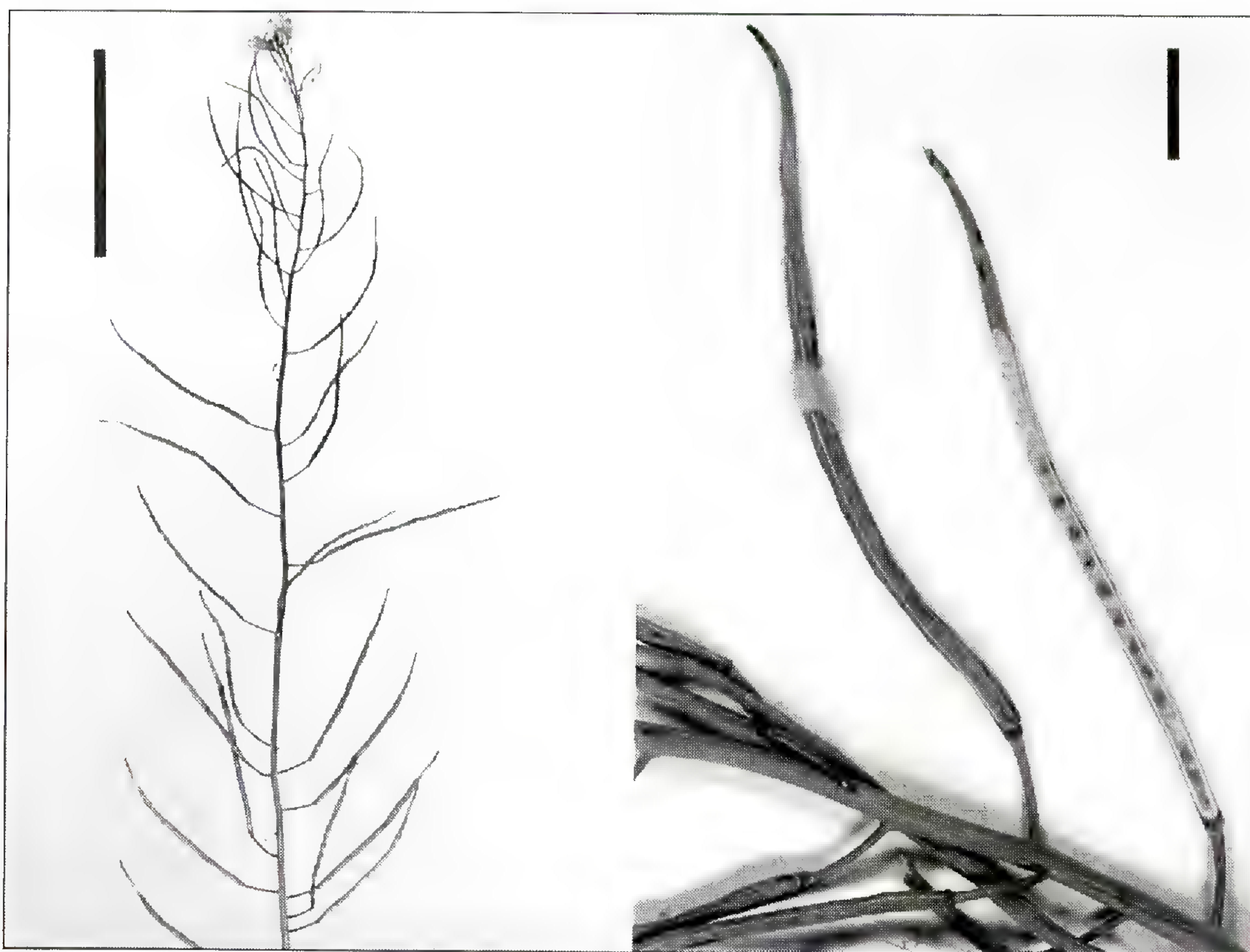
FIGS. 1–2. *Coincya monensis*. Fig. 1 (left). Basal portion of plant. Fig. 2 (right). Selection of leaves from a single plant of *Coincya monensis*. The amount of lobing of the leaves decreases from the base of the plant to the base of the inflorescence. Vertical bar represents 5 cm for both figures.

by Al-Shehbaz (1984) and in his key to southeastern United States genera of Brassiceae (Al-Shehbaz 1985).

Taxonomy and nomenclature of *Coincya* were discussed by Leadlay and Heywood (1990), who recognized five subspecies of *C. monensis*. Further discussions of the species' nomenclature are in Kartesz and Gandhi (1994) and Rollins (1961, 1993). Our plants are subsp. *recurvata* (All.) Leadlay, a taxon burdened by no fewer than 129 synonyms. This subspecies has the same indigenous range in the Old World as that of the collective species: Corsica, France, Germany, Great Britain, Italy, Morocco, Portugal, and Spain (Leadlay & Heywood 1990).

INVASION AND SPREAD

Except for the species' convoluted nomenclature, the invasion history of *C. monensis* in North America is straightforward. Apparently there are five areas in eastern United States in which the plant has appeared (Fig. 5), one of these in the late 1800s only, the others after the middle of the 20th century. In the Philadelphia/Hoboken area it was collected on ballast in



FIGS. 3–4. *Coincya monensis*. Fig. 3 (left). Fruiting branch. Vertical bar represents 5 cm. Fig. 4 (right). Fruits, one with one valve removed. Note conspicuous beak and the one row of seeds. Vertical bar represents 1 cm.

the 1870s to at least 1890. Then, in 1958, it was found in far western North Carolina, where it has persisted at least into the 1990s. Then followed Pennsylvania and southern New York, where the species was first collected in 1964 and where we made 22 collections of it in 1992, 1994, and 1995. In southwestern Michigan it was first collected in 1989 and again in 1993. Finally, the species was found in Kentucky in 1996.

Philadelphia/Hoboken area on Ballast (1870s to at least 1890)

Coincya monensis was one of many species introduced in ships' ballast in the late 1800s. Soil, sand, and rocks incidentally containing seeds were loaded onto ships in Europe and then exchanged for cargo in the United States. Studies of these ballast floras recorded at least 386 species associated with ballast in New Jersey, New York, and the Philadelphia area alone (Muehlenbach 1979).

The earliest North American reports of *C. monensis* we have located—all from ballast in the vicinity of Philadelphia—are those of Burk (1877) and Martindale (1876, 1877). Further ballast collections were made by Brown (1879, 1880) from Hoboken, New Jersey. In these early reports the species

TABLE 1. Characteristics distinguishing *Coincya* from selected genera of Brassicaceae with which it has most often been confused in eastern North America.

From <i>Brassica</i>	
<i>Coincya</i>	<i>Brassica</i>
Valves of fruit with 3–5 veins	Valves of fruit with 1 vein
From <i>Diplotaxis</i>	
<i>Coincya</i>	<i>Diplotaxis</i>
Seeds in 1 row in fruit	Seeds in 2 rows in fruit
Beak of fruit broad, somewhat flattened, 15–20 mm long, ca. 2 mm wide at base	Beak of fruit style like, 1.5–3 mm long
From <i>Erucastrum</i>	
<i>Coincya</i>	<i>Erucastrum</i>
Inflorescence ebracteate (occasionally an elongate, entire bract at base of most proximal pedicel)	Inflorescence bracteate at least at the most proximal pedicels, the bracts pinnately lobed
Beak of fruit broad, somewhat flattened, 15–20 mm long, ca. 2 mm wide at base	Beak of fruit slender, style-like, to 4 mm long
From <i>Sinapis</i>	
<i>Coincya</i>	<i>Sinapis</i>
Veins of petals darker in color than the rest of the blade	Petals uniform in color
Sepals erect, connivent, the inner two saccate at base	Sepals tend to be spreading (rarely reflexed), not connivent, not saccate at base

was called “*Brassica monensis*” or “*B. cheiranthus*.” It was present at Philadelphia until at least 1890 (the date of the most recent ballast specimen we have seen). At the 19th century ballast sites, *C. monensis* was described as being “scarce” (Brown 1879) to “quite common” (Martindale 1877). Changes in regulations regarding the disposal of ballast eventually closed this avenue of introduction.

These early introductions on ballast apparently did not lead to naturalization of the species in North America. Such naturalization followed only after the post-1950 appearances of the species on the continent.

Far Western North Carolina (1958–Present)

After a hiatus of about seven decades, the plant was again found in North America: collections of it from far western North Carolina (Yancey County) made in 1958 were reported by Ahles and Radford (1959) but under the misidentification *Diplotaxis muralis*; this misidentification was “corrected” in the *Vascular flora of the Carolinas* (Radford et al. 1968), where the species appears as *Brassica erucastrum* L., a misapplied name (Al-Shehbaz 1985; Leadlay & Heywood 1990). The North Carolina collections were discussed by Rollins (1961).

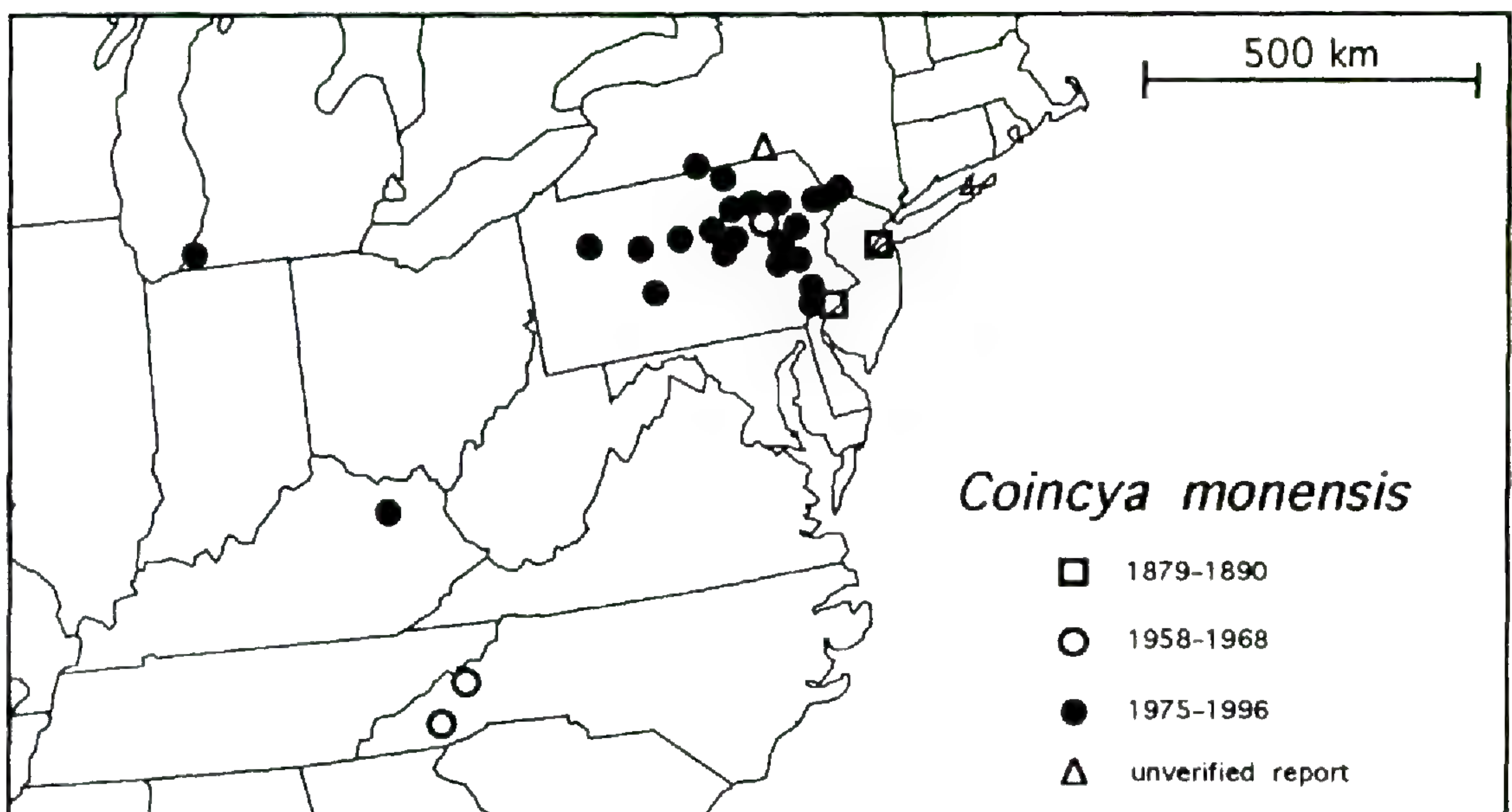


FIG. 5. *Coincya monensis*. Documented range in North America. Symbols indicate year of first collection from a county.

At the sites of this first United States collection in the 20th century, the species was said to be “very abundant, turning roadsides and fields into a yellow haze for miles around when in flower, particularly in the Cane River Valley. As a weed, it would seem to have the potential of becoming a very serious pest” (Ahles & Radford 1959).

The most recent collection of *coincya* we have seen from North Carolina was made in 1994, again in the far western part, about 15–20 miles south of the sites of the original collections from the state.

Pennsylvania/New York (1964–Present)

Pennsylvania.—The earliest 20th century collection of *C. monensis* we have located from Pennsylvania (Luzerne County) is dated 1964. The first published Pennsylvania record is in *Atlas of the flora of Pennsylvania* (Wherry et al. 1979). The updated Pennsylvania atlas (Rhoads & Klein 1993) reported the plant from two counties (Clearfield & Luzerne), mentioning that it is “apparently spreading along Interstate 80.”

Our Pennsylvania collections, made in 1992, 1994, and 1995, are from 19 counties.

New York.—We suggest that *coincya* is spreading into New York from Pennsylvania and that the species will become more common in New York than it seems to be now. We know of two collections and one undocumented report from the state, all near the Pennsylvania border. Both of the New York specimens are from the 1990s: a JWT collection from a roadside near Port Jervis in Orange County; and a Chapman collection from “steep rocky walls and small cliffs” at South Addison in Steuben County. The report is in notes accompanying W. Chapman’s Bradford County, Pennsyl-

vania, collection, which mention that the species is “rare in New York, though it occasionally shows up in the south-central (Binghamton) area.” We located no verifying voucher, although we have no reason to doubt the report’s accuracy.

Michigan (1989–Present)

Swink and Wilhelm (1994) reported collections of the species from southwestern Michigan (Berrien County) in 1989 and 1993. The sites where the plant was found are only about 30 miles north of Interstate 80, the highway along which JWT first noted the plant in Pennsylvania ca. 400 miles to the east.

Kentucky (1996–present)

The first collection of the species from Kentucky was made in 1996 in Rowan County on a rocky roadside slope.

Our map shows not only the documented occurrences of *C. monensis* in North America but also clearly where we made a special effort to search out the species in 1994 and 1995 in Pennsylvania. The advance of *coincya* in Pennsylvania may have been rather rapid: from one county in 1964 to at least 20 counties ca. 3 decades later. We predict with confidence that the range of *C. monensis* will increase. Indeed, the plant is probably already in some states additional to those reported here, having been overlooked or simply ignored by collectors, many of whom do not collect roadside weeds (especially those resembling *Brassica*, so commonly seen but not an esteemed prize for collectors). Indeed, we suggest that in some herbaria from which we did not request loans—and maybe even in those 36 herbaria from which we received no response to our loan request—there might be specimens from states other than those we have verified.

That seeds of *C. monensis* were introduced via ballast at the 19th century sites is clear. The source of the disseminules for the post-1950 introductions is unknown.

Two patterns of spread by invading plants were distinguished by Baker (1974). In the first, “echelon” movement, a species has a single point of introduction followed by movement across the landscape in wave- or step-like progression. In the second, “spot and fill,” several centers of introduction may be followed by a filling in of the intervening open spaces. The pattern exhibited by *C. monensis* in North America in the 20th century would appear to be “spot and fill,” with the “filling in” yet to develop fully.

The European range of *C. monensis* subsp. *recurvata* is from southern Spain north to western Germany and northern Scotland, covering ca. 21° of latitude (Leadlay & Heywood 1990). This range extends from hardiness zone 10 (minimum 30° to 40° F) to zone 7 (minimum 0° to 10° F)

(Krüssmann 1984). Considering temperature alone, we note that, in North America, the species already occurs in colder areas (zone 5, minimum -20° to -10° F) than in Europe.

ECOLOGY

One Pennsylvania herbarium specimen (Bradford County, near Wyalusing, "late July" 1983, *Chapman s.n.* [BH]) has attached to it copies of two letters in which are useful data. Chapman wrote in 1983 that the species' preferred habitat is "along the edge of rock ledges . . . and at the bases of such cliffs . . . especially in those areas where small cliffs are formed by the highway department's cutting through a hill to make a road." He further noted that the plants "often live 2–3 years and set a full crop of seeds each year."

The habitats mentioned by Chapman are precisely those from which most of our collections came; particularly impressive is the plant's abundance in some of those habitats. In addition, we have seen the plant among cobbles placed on roadside slopes to retard erosion, along railroad tracks, at weedy edges of roadside rest areas, and at disturbed sites at service stations and motels. Many of the sites in which it grows are gravelly or rocky.

The synanthropes associated with *coincya* in its weedy habitat are frequent to common along highways over much of northeastern United States. We noted *Capsella bursa-pastoris*, annual species of *Cerastium*, *Coronilla varia*, *Erigeron canadensis*, *Erysimum repandum*, *Lotus corniculatus*, *Polygonum aviculare*, *Silene antirrhina*, *S. cucubalus*, and *S. pratensis* (*Lychnis alba*). Some associates of *coincya* in southwestern Michigan are listed in Swink and Wilhelm (1994). We noted in Pennsylvania, though, that *coincya* often dominated its habitat to the apparent exclusion of other species. A single, vigorous plant of *C. monensis*, sometimes nearly 1.5 m long (individuals that large are sprawling, not erect), is seemingly a formidable competitor, capable of covering a large area. Occasional plants of *C. monensis* may be found growing in the midst of otherwise continuous *Coronilla varia*.

Additional data on biology of the species are in Hegi (1918 [under *Brassicella erucastrum*], 1986 [under *Rhynchosinapis cheiranthos*]) and Leadlay and Heywood (1990).

We hope that our summary of data on this species will provide baseline data of some use to future investigators of the spread of the plant.

ACKNOWLEDGMENTS

We thank the herbaria that responded to our request for loans: United States: BH, BHO, BRL, BUT, CCNL, CHRB, CLEMS, CLM, CM, CONN, DAV, DEK, DOV, F, FLAS, FSU, GH, HNH, IA, ISC, KANU, KE, KSC, LSU, LYN, MASS, MICH, MIN, MO, MOR, MSC, MU, MUHW, MWI,

NCBS, NCSC, NCU, NDG, NHA, NLU, NY, NYS, ODU, OSC, PAC, PH, PUR, RSA, SDC, SIU, SLRO, TEX, UARK, UC, UMO, UNA, UNCC, US, USCH, UTC, VDB, VPI, VT, WILLI, WIS, WVA, YU. Canada: ACAD, ALTA, CAN, DAO, HAM, MMMN, MT, MTMG, NBM, NFLD, NSPM, OAC, QFA, QK, QUE, SASK, SCS, SFS, TRT, UBC, USAS, UWPG, WAT. The Lloyd Library, Cincinnati, was invaluable for our literature searches. The Spanish translation of the abstract was provided by Dr. Miriam Steinitz-Kannan. Our wives, Mary A. Naczi and Mildred W. Thieret, assisted with field work.

APPENDIX

Coincya monensis—Herbarium Specimens Seen

KENTUCKY. Rowan Co.: 3.5 air mi NE of center of Morehead, along W side of route 32, 1 Jun 1996, *Naczi & Trauth* 5561 (BRIT, KNK, US, VDB).

MICHIGAN. Berrien Co.: Coloma, sandy soil along railroad, 29 Aug 1993, *Wilhelm & Dritz* 21866 (MICH, MOR); Coloma, weedy hill, 16 Aug 1993, *Wilhelm & Dritz* 21579 (MOR); Coloma, sandy soil, 3 Jul 1993, *Dritz* 1115 (MOR); roadside between Coloma and Watervliet, 9 Jun 1989, *Swink & Wetstein* 8600 (MOR); near a large sandpit between Coloma and Watervliet, 30 May 1989, *Swink & Wetstein* 8430 (MOR).

NEW JERSEY. [Hudson Co.]: Hoboken, ballast, 25 Oct 1879, *Brown s.n.* (AC, NY); Hoboken, ballast filling, Jul 1880, *Brown s.n.* (BH, GH, US); Hoboken, ballast, 28 Oct 1879, *Schrenk s.n.* (NY); Hoboken, ballast, 3 Jul 1880, *Martindale s.n.* (CHRB).

NEW YORK. Orange Co.: roadside along I-84, ca. 1.5 mi E of Port Jervis, 10 Sep 1995, *Thieret* 59751 (KNK). **Steuben Co.:** steep rocky walls and small cliffs overlooking Tuscarora Creek along route 417, South Addison, [no day, no month] 1994, *Chapman s.n.* (NYS).

NORTH CAROLINA. Jackson Co.: field 3.9 mi NE of Cherokee, 7 May 1968, *Leonard & Radford* 1453 (CHRB, FLAS, FSU, ISC, KE, LL, MBG, MIN, NCU, NCY, NHA, NLU, NY, ODU, PAC, PUR, SIU, TEX, UNA, UTC, VDB, WIS, WVA). **Yancey Co.:** roadside 0.8 mi SE of Pensacola, 27 Apr 1958, *Ables & Duke* 39158 (NCU); roadside 1.8 mi SW of Burnsville, 7 Jun 1958, *Ables & Duke* 42855 CAN, FLAS, KANU, MICH, NCU, NY, RSA, SIU, VDB); roadside 2.9 mi SW of Burnsville, 7 Jun 1958, *Ables & Duke* 42859 (NCU); roadside 0.9 mi NW of Ramsaytown, 16 Jul 1958, *Ables & Duke* 46824 (FSU, NCU); roadside, Cane River, W of Burnsville, 9 Oct 1958, *Ables & Duke* 50846 (NCU); wet rocky face of slope along Blue Ridge Parkway 7.2 mi NE of Black Mountain Gap, 6 Aug 1994, *Vincent & Lammers* 6739 (MU, VDB).

PENNSYLVANIA. (NT=collection by R.F.C. Naczi and J.W. Thieret; NN=collection by R.F.C. Naczi and M.A. Naczi; T=collection by J.W. Thieret.) **Blair Co.:** roadside 17 mi S of Altoona, 13 Jun 1994, *NT* 4109 (KNK). **Bradford Co.:** roadside, Indian Prayer Rocks, near Wyalusing, [no day] July 1983, *Chapman s.n.* (BH); roadside, Troy, 15 Jun 1994, *NT* 4159 (KNK); along railroad tracks, Towanda, 16 Jun 1994, *NT* 4237 (KNK). **Carbon Co.:** roadside just E of East Side, 18 Jun 1994, *NT* 4356 (KNK). **Clarion Co.:** roadbank 2 mi SW of Clinton, 4 Jul 1995, *NN* 4907 (CM, KNK, MICH, PAC, PH, VDB). **Clearfield Co.:** roadside, Clearfield, 19 Aug 1992, *T* 58141 (KNK). **Clinton Co.:** roadside 2 mi NNW of Loganton, 14 Jun 1994, *NT* 4120 (KNK). **Delaware Co.:** roadside 10 mi S of Norristown, 18 Jun 1994, *NT* 4359 (KNK). **Lackawanna Co.:** roadside 2 mi SW of Mt. Cobb, 1 Jul 1995, *NN* 4870 (KNK, PH). **Lehigh Co.:** roadside, Allentown, 18 Jun 1994, *NT* 4357 (KNK). **Luzerne Co.:** roadside, Hazelton, 10 Sep 1995, *T* 59750 (KNK); roadside 2.5 mi SE of Briggsville, 27 Jun 1964, *Wahl* 21003 (FSU, ISC, MASS, PAC, UC, VDB). **Lycoming Co.:** roadside 1 mi NE of Picture Rocks, 14 Jun 1994, *NT* 4123 (KNK). **Monroe Co.:** roadbank SE of Stroudsburg, 9 Jun 1975, *Rosbach* 9216a (WVA). **Montgomery Co.:** roadbank 5 mi NE of Norristown, 18 Jun 1994, *NT* 4358 (KNK). **Northumberland Co.:** roadside 2 mi NW of Turbotville, 14 Jun 1994, *NT* 4122 (KNK). **Philadelphia Co.:** ballast, West Philadelphia, 22 Jun 1890, *Mc Elwee* 570 (PH). **Pike Co.:** roadside 3.5 mi SSW of Tafton, 1 Jul 1995, *NN* 4882 (CM, KNK, PH); roadside 3 mi NW of

Milford, 3 Jul 1995, *NN 4883* (CM, KNK, PAC, PH). Schuylkill Co.: roadside between McAdoo and Delano, 10 Sep 1995, *T 59751* (KNK). Sullivan Co.: roadside 5 mi SW of Laporte, 14 Jun 1994, *NT 4124* (KNK). Union Co.: roadside 7 mi NW of New Columbia, 14 Jun 1994, *NT 4121* (KNK). Wayne Co.: roadside 5 mi NNW of Pocono Springs, 1 Jul 1995, *NN 4871* (CM, KNK, PH). Wyoming Co.: roadside 1.5 mi SE of Meshoppen, 18 Jun 1994, *NT 4353* (KNK).

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ANNOUNCEMENT

The Council of the New England Botanical Club wishes to announce that there are no longer page charges for publication in *Rhodora*. The Council has appointed Janet R. Sullivan Editor-in-Chief and Margaret Bogle Managing Editor, beginning with volume 98. Any new manuscripts should be submitted to: Dr. Janet R. Sullivan, Department of Plant Biology, University of New Hampshire, Durham, NH 03824-3597: (603) 862-4757, e-mail: janets@christa.unh.edu. Monographs or scientific papers concerned with systematics, floristics, ecology, paleobotany or conservation of the flora of North America or floristically related areas will be considered.

RESEGREGATION OF *BARBIERIA* FROM *CLITORIA* (LEGUMINOSAE: PHASEOLEAE: CLITORIINAE)

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ABSTRACT

Barbieria is a monotypic genus that was transferred to subtribe Clitoriinae and included within the genus *Clitoria* in 1981 by Lackey. The morphology of *Barbieria* is compared with *Clitoria* and contrasted with genera *Centrosema*, *Periandra* and *Clitoriopsis*. *Barbieria* is found to be an aberrant member of *Clitoria* with characters supporting its recognition as a separate genus in the Clitoriinae. A key to genera of subtribe Clitoriinae and a taxonomic treatment of *Barbieria* is presented.

RESUMEN

Barbieria es un género monotípico que fue transferido a la subtribu Clitoriinae e incluido dentro del género *Clitoria* por Lackey en 1981. La morfología de *Barbieria* se compara con *Clitoria* y se contrasta con los géneros *Centrosema*, *Periandra* y *Clitoriopsis*. *Barbieria* ha resultado ser un miembro aberrante de *Clitoria* con caracteres que corroboran su reconocimiento como un género separado en Clitoriinae. Se presenta una clave de los géneros de la subtribu Clitoriinae y el tratamiento taxonómico del género *Barbieria*.

Barbieria DC. is a monotypic genus of questionable taxonomic affinities, having been placed historically into several tribes including its own. Lackey (1981) assigned *Barbieria* to subtribe Clitoriinae Benth. (Leguminosae Juss., Phaseoleae DC.), and concluded that it was a member of the genus *Clitoria* L. Mabberley (1987) and Smith and Lewis (1991) recently reconfirmed *Barbieria* as a synonym of *Clitoria*. My preparation of manuscripts for the genera *Clitoria* and *Centrosema* (DC) Benth. for Douglas Stevens' *Flora de Nicaragua* Project, Julian Steyermark's *Flora of Venezuelan Guayana* Project, and the *Flora Mesoamerica* Project required examination of specimens of *Barbieria* throughout its range.

I strongly disagree with Lackey's assignment of *Barbieria* to *Clitoria*. *Barbieria* has a number of characters that make it an aberrant member when placed within *Clitoria*. Proponents of Lackey regarded the morphological differences as minor, due to the adaptation of *Barbieria* from bee to bird pollination. The objective of this paper is to compare the morphological characters of *Barbieria* with *Clitoria*, as well as contrast differences with other genera to support its recognition as a distinct genus within the Clitoriinae.

SUBTRIBE CLITORIINAE

Lackey (1981) recognized four genera in Phaseoleae subtribe Clitoriinae: *Centrosema* (DC.) Benth., *Periandra* Benth., *Clitoria* L. and *Clitoriopsis* Wilczek. He characterized the subtribe by the resupinate flowers, naked calyx interior, and presence of bracteoles and hooked [micro-uncinate] trichomes. Leaves were reported to be 3- or 1-foliolate, to 5–9-foliolate in a few members of *Clitoria* and *Centrosema*.

These four genera also are similar in other respects. They are woody genera with members being trees, shrubs to shrublets, lianas, or suffrutescent herbs (= subshrubs of some authors). The more advanced species have an underground xylopodium from which arises one or more aerial stems annually during the rainy season. These stems produce leaves, flowers and fruits, then die back to near ground level during the dry season. Collectors frequently only voucher the aerial stems, leading some early and modern authors to treat these plants (and genera) as herbaceous or even as annuals.

Leaves are pinnately compound with 3-foliolate leaves being prevalent, 3–7-foliolate leaves being infrequent (5 species) and 7–11-foliolate leaves being rare, occurring only in *Clitoria lasciva* Boj. ex Benth. Stipules and stipels are persistent and striate. Inflorescences are pseudoracemose, often axillary, multiflowered, bearing flowers on paired pedicels, or reduced to 1–2 apical flowers. Bracts are persistent and striate. Bracteoles persist and commonly are appressed to the calyx. Flowers are resupinate and large in size, with smaller flowers being 2.5–4 cm long. The calyx has five teeth with the upper two (dorsal) subconnate and the vexillary tooth commonly longer. Petals are clawed with the vexillum large, showy, obovate to suborbicular, prominently veined and complicate. The vexillary stamen is free to more or less connate basally; the staminal sheath is incurved; anthers are yellow. The ovary is densely pubescent, subsessile, with a 1–2 mm gynophore or prominently stipitate; the style is incurved. Fruits are linear, straight to falcate, short-stipitate (subsessile) to prominently stipitate, beaked, with dehiscence by spiral twisting of the valves. Pubescence consists of macrotrichomes easily viewed at 10X and micro-uncinate trichomes hidden beneath and more easily viewed at 30X.

The four recognized genera can be segregated on several morphological features of the flowers and fruit (Table 1). The calyx is campanulate (*Centrosema*, *Periandra*) or infundibular (*Clitoria*, *Clitoriopsis*). The lengths of the vexillum, wing and keel petals vary, but the keel petal is shortest in all genera. Anthers are uniform or rarely dimorphic (*Clitoriopsis*). Curvature of the style varies, as does the degree of dilation near the stigma and its pubescence. Fruits are ecostate or costate, flat or turgid, and if turgid, vary in degrees of depression between seeds.

TABLE 1. Comparison of genera in subtribe *Clitoriinae*.

Character	Centrosema	Periandra	Clitoria	Clitoriopsis
CALYX	Campanulate	Campanulate	Infundibular	Narrow infundibular
PETALS				
Vexillary spur	Present	Absent	Absent	Absent
Auricled wing	Present	Present	Present	Present
Wing vs vexillum	Much shorter	Much shorter	Much shorter	Slightly shorter
Keel vs vexillum	Much shorter	Much shorter	Much shorter	Slightly shorter
Keel vs wing	Slightly shorter	Slightly shorter	Much shorter	Subequal
GYNOECIUM				
Ovary	Subsessile	subsessile	Stipitate or few subsessile	Stipitate
Style curvature	Broad U-shaped	Broad J-shaped	Geniculate	Weakly incurved
Style pubescence	Barbellate basally	Glabrous	Barbellate apically	Glabrous
ANDROECIUM				
Anthers	Uniform	Uniform	Uniform	Dimorphic
FRUIT				
Costa	2 per valve	Absent	1 per valve or absent	Absent
Valves	Flat	Flat	Flat or turgid	Flat
Depression between seeds	Absent	Absent	Absent to present	Absent
LEAVES				
Leaflet number	(1)3 (5–7)	(1)3	(1)3 (5–11)	3

THE GENUS *CLITORIA*

Species of *Clitoria* fall into three distinct groups based upon morphology. Fantz (1979) reported that botanists have traditionally treated these groups as sections. However, one could argue that these groups represent three distinct genera due to morphological differences in the calyces and fruits supported by leaflet number and habit. However, all three groups are similar in floral characters that are unique within the papilionaceous legumes. Flowers are resupinate, large and showy, with stalked ovaries bearing geniculate, bearded styles, within infundibular calyces that persist in fruit. Bentham (1858) concluded that *Clitoria* would be rendered more natural by retaining these groups together than by segregation, and treated them as sections. Baker (1879) elevated two sections to subgenus *Clitoria* and subgenus *Neurocarpum* (Desv.) Bak. Fantz (1979) agreed with Bentham and elevated the third section to subgenus *Bractearia* (Mart. ex Benth.) Fantz.

MORPHOLOGY OF *BARBIERIA*

Lackey (1981) did not indicate affinities of *Barbieria* within the genus *Clitoria*. *Barbieria* consists of one species (a liana) with a wide distribution, occurring in the western Antilles and southern Mexico south to Peru, east to Brazil. Botanists often note *Barbieria* as rare to infrequently observed in the localities where the species is collected. The morphology of *Barbieria* will be reviewed in the following discussions with comparisons made to *Clitoria* and to other genera of Clitoriinae to determine potential affinities.

Inflorescence.—Similarities to the Clitoriinae include axillary pseudo-racemes, persistent bracts and bracteoles, paired flowers, and micro-uncinate trichomes. Inflorescences in *Barbieria* are elongate, slender, and multi-flowered. The closest placement in *Clitoria* would be subg. *Bractearia*. However, inflorescences of *Bractearia* are nodose, and often are borne cauliflorously in lianaceous species before leaves and axillary inflorescences are produced, characters not noted in *Barbieria*. Bracts of *Clitoria* are in three series. The inner pair is smallest, caducous to deciduous, located between the pedicels; the middle pair is largest, persistent, located opposite the pedicels; and the outer pair are deciduous to semipersistent, nearly as large as the middle pair, and located between the pedicels. *Barbieria* appears to have bracts only in two series. An inner row of bracts has not been observed. Bracts and bracteoles (Fig. 1F) of *Barbieria* are acuminate to subulate apically, unlike any *Clitoria* or other genus in the Clitoriinae. Bracteoles of *Bractearia* are described by collectors as dark greenish-yellow to strong reddish-orange. Bracteoles of *Clitoria*, when noted by collectors, are described always as shades of green.

Flowers.—Similarities to the Clitoriinae include the large, showy, resupinate flowers with clawed petals and complicated banner petal. Mature flowers of *Barbieria* appear dissimilar to those of *Clitoria* (Fig. 1A), with the banner petal spreading downward away from the conspicuously protruding keel. *Clitoria* has the banner broadly U-shaped around the keel, the latter inconspicuous and somewhat hidden by the flaring apices of the wing petals. Color is commonly associated with the standard, with *Barbieria* described as scarlet or vivid to brilliant red, a color not associated with *Clitoria*, but is associated with some *Periandra*. Nectar guides are inconspicuous. Flowers of *Clitoria* bear a standard with blue to lilaceous to violaceous pigmentation, or white, with numerous conspicuous veins of darker pink to violet hues commonly from a yellowish to whitish medial patch. Proponents of Lackey noted that *C. javitensis* (H.B.K.) Benth. has light red flowers, but the floral pigmentation is violaceous-pink, not red. Wings and keels of *Clitoria* are described as pale or off-white with the wings bearing violaceous pigmentation near the apex of the flaring blade.

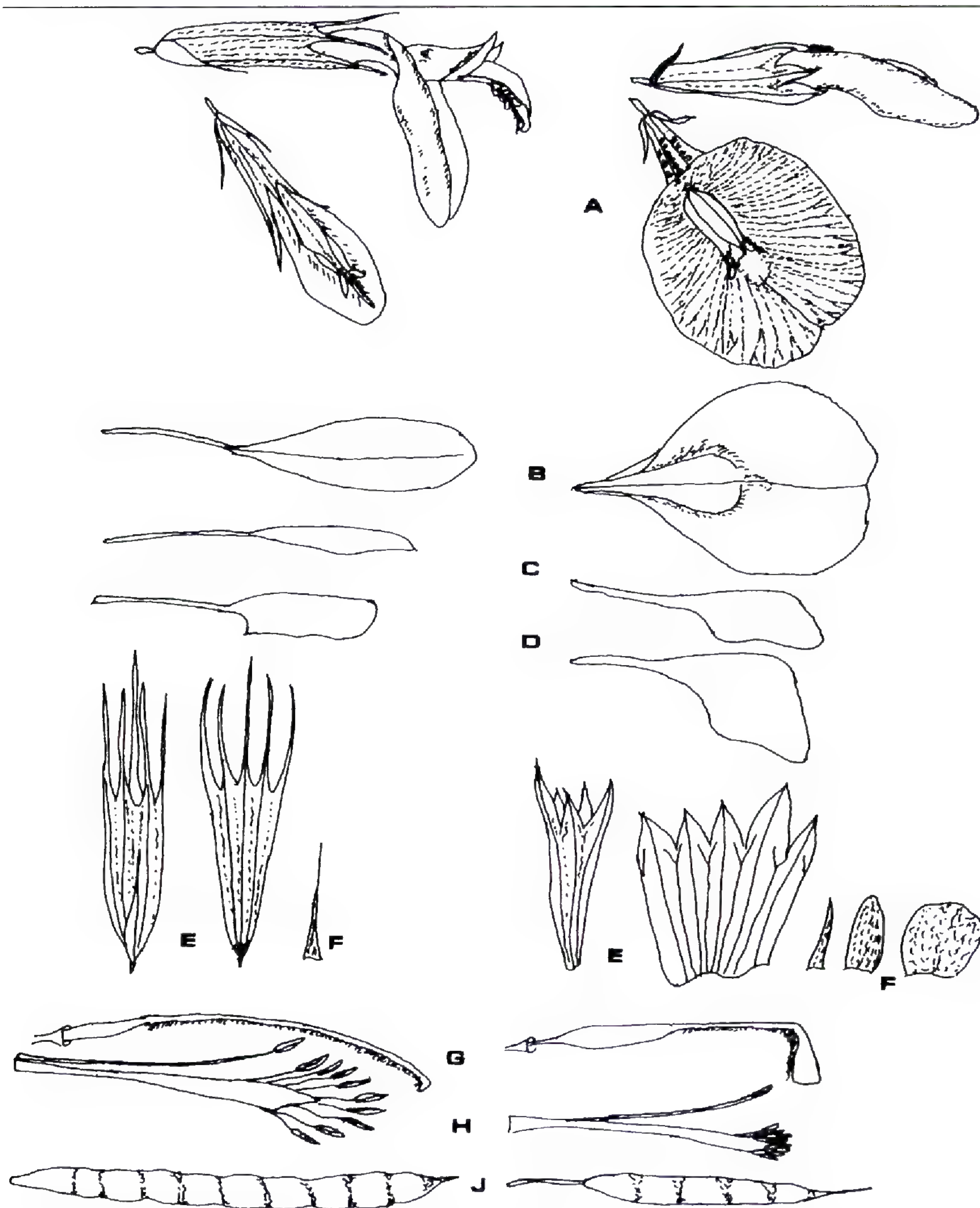


FIG. 1. A comparison of some morphological features of *Barbieria* (left) with *Clitoria* (right). A: Flower, two views. B: Standard or banner (vexillum) petal. C: Keel (carina) petal. D: Wing (alae) petal. E: Calyx, intact and split-open views. F: Bracteole(s). G: Gynoecium. H: Androecium. J: Legume; *Clitoria* subg. *Neurocarpum* represented.

Calyx.—The calyx (Fig. 1E) of *Barbieria* is narrowly infundibular making it similar to *Clitoriopsis*, not *Clitoria*. The calyx tube of *Barbieria* is elongated, appearing somewhat cylindrical with a length/width ratio of 4–5, and is 20-veined. A prominent raised vein extends into each lobe with three smaller veins in between, one extending to the sinus, and the other

pair into each adjacent lobe. Calyx lobes are deltoid-ovate basally with elongated subulate apices. The upper dorsal pair are free nearly to the base. The calyx is described as dark to vivid to blood red in color. *Barbieria* is unique within the Clitoriinae in bearing the upper calyx lobes free and bearing subulate apices.

The calyx of *Clitoria* is infundibular. The calyx tube does not appear elongated, as the length/width ratio is 2–3. The venation pattern is striated in subg. *Bractearia* and 10-veined in the other two subgenera, with a prominent vein into each lobe and into each sinus. Calyx lobes are acute to short-acuminate, not subulate apically. The upper dorsal pair is subconnate. The calyx, when noted by collectors, is described as green to purplish-tinged.

Petals.—*Barbieria* has an elongated oblong-ob lanceolate standard (Fig. 1B) with the keel length subequal the standard (as in *Clitoriopsis*) and wings much shorter than the keel. The shape of the standard and the wings being much shorter than the keel are unique characters within the Clitoriinae. The standard is broadly ovate to suborbicular in all other genera of the Clitoriinae. The wings are subequal to slightly longer than the keel in the other genera, except for *Clitoria*, where the wings are conspicuously much longer with flaring apices.

The keel blade (Fig. 1C) in *Barbieria* is narrow elliptic-oblong, acute, and weakly incurved. The keel blade in *Clitoria* is broadly oblong, broadly acute to subobtuse, and strongly falcate. The wing petals (Fig. 1D) have nearly straight, oblong blades in *Barbieria*. The wings of *Clitoria* have strongly falcate, oblong-spatulate blades.

Gynoecium.—*Barbieria* has a sessile ovary (Fig. 1G) with a gynophore lacking, to 0.5 mm long. The style is linear, not dilated above, barbellate much of its length, and scarcely geniculate just below the stigma. This gynoecium is unique within the Clitoriinae as other genera bear a gynophore below the ovary and have an incurved style dilated above. *Clitoria* has a stalked ovary (rarely subsessile) with a style distinctly geniculate, with the style dilated and bearded above the abrupt incurved point. A subsessile ovary (gynophore 1–4 mm long) occurs in *Centrosema* and *Periandra*.

Androecium.—The vexillary stamen in *Barbieria* (Fig. 1H) is free at the base with the others connate, similar to *Clitoriopsis*. The nine connate stamens bear anthers on elongated filiform filaments as in *Clitoriopsis* and *Periandra*. *Barbieria* is unique in bearing white anthers (yellow in other genera). The vexillary stamen in *Clitoria* is more or less connate at the base. Nine stamens are connate with short filaments bearing yellow anthers.

Legume.—The legume (Fig. 1J) of *Barbieria* is sessile, linear, ecostate, and enclosed at the base by the persistent calyx. The valves are strongly-transversely impressed between the seeds, turgid and convex around the seeds. The style scarcely persists as a beak. Legumes are variable in *Clitoria*,

but stipitate and bearing a beak. Legumes are flat in subgenera *Bractearia* and *Clitoria*, and other genera of subtribe Clitoriinae. Legumes of subgenus *Neurocarpum* are turgid, convex around the seeds, and ecostate to costate with a medial raised vein on the valve.

Seeds.—Seeds of *Barbieria* are viscid, a character found elsewhere only in *Clitoria* subgenus *Neurocarpum*. The other subgenera of *Clitoria* and genera of Clitoriinae have smooth seeds.

Leaves.—Leaves of *Barbieria* are similar to Clitoriinae by being odd-pinnately compound, petiolate, bearing persistent stipules and stipels and micro-uncinate trichomes beneath macrotrichomes. Leaflets are commonly 15–21, oblong and obtuse. The only close match in leaflet number is *C. lasciva* Bojer ex Benth. (subg. *Clitoria*), a Madagascan endemic with 7–11-foliolate leaves. Lackey (1981) omitted reporting this higher leaflet number in the characterization of the subtribe and commented that *Clitoria* subg. *Clitoria* [reported as sect. *Ternatea*] is more reminiscent of some Galegeae.

CONCLUSION

Clitoria is a genus with morphological variation in the habit, leaflet number, calyx and fruits. However, flowers are similar in structure in all subgenera, and unique within the papilionaceous legumes. Flowers are resupinate, large and showy, with stalked ovaries bearing geniculate, bearded styles, within broad infundibular calyces that persist in fruit.

Barbieria becomes an aberrant member of genus *Clitoria* when placed in any subgenus. *Clitoria* subgenus *Bractearia* can be segregated from *Barbieria* by the nodose pseudoracemes, flat prominently stipitate fruits of much larger size, multistriated calyx, and trifoliolate leaves. *Clitoria* subgenus *Clitoria* can be segregated from *Barbieria* by the flat, short-stipitate fruits, 10-veined calyx, and suffrutescent habit. *Clitoria* subgenus *Neurocarpum* can be segregated from *Barbieria* by the trifoliolate and unifoliolate leaves, 10-veined calyx, stipitate fruits and non-lianaceous habit.

Should *Barbieria* be placed in a separate subgenus within *Clitoria*? Not in my view. Table 2 contrasts these two genera. *Barbieria* can be segregated from all species of *Clitoria* by the scarlet color of the flowers, the oblong shape of the standard blade borne on a long claw, the length of the various petals with the wing petals being the shortest and the keel subequal the standard, the standard spreading away from the keel at maturity, the sessile ovaries and fruits with inconspicuous beaks, the free calyx lobes on a narrower, elongated tube (length 4–5 times longer than wide) with 20 veins, the subulate apices of bracteoles, bracts, stipules, and calyx lobes, the bracts oriented in two series, the free vexillary stamen, white anthers, elongate free filaments, a slender non-dilated style barbellate lengthwise, and higher leaflet number.

TABLE 2. Morphological comparison of *Barbieria* and *Clitoria*.

Character	Barbieria	Clitoria
HABIT	Liana	Tree, Shrub, Liana, Suffrutescent Herb
LEAVES		
Leaflet Number	(9)13–25	(1)3 (rarely 5–11)
Stipule apex	Subulate	Acute
INFLORESCENCE		
Bract series	2 rows	3 rows
Bract apex	Subulate	Acute to obtuse
Bracteole apex	Subulate	Acute to obtuse
Bracteole color	Greenish-yellow/ reddish-orange	Green
Flower color	Red	White or blue to violaceous, rarely pink
Vexillum (vs Keel)	Spreading	Surrounding keel
CALYX		
Tube configuration	Narrow infundibular	Broad infundibular
Tube L/W ratio	4–5	2–3
Tube veination	20-veined	10-veined or striate
Tube color	Dark red	Green to purplish tinged
Lobe shape	Broad, subulate	Deltoid
Fusion upper 2 lobes	Nearly free	Subconnate
COROLLA		
Standard shape	Oblong-ob lanceolate	Obovate
Standard claw	Long-clawed	Short-clawed
Wing shape	Oblong	Falcate-oblong
Keel (vs wings)	Longer	Shorter
Keel (vs standard)	Subequal	Much shorter
GYNOECIUM		
Ovary	Sessile	Stalked
Style curvature	Weakly incurved	Geniculate
Style pubescence	Barbellate length	Barbellate apically
Style apex	Not enlarged	Dilated
ANDROECIUM		
Vexillary stamen	Free to base	Connate near base
Free Filaments	Elongate, filiform	Short
Anthers	White	Yellow
LEGUME		
Attachment	Sessile	Stipitate
Surface	Turgid around seeds	Flat or turgid around seeds
Beak	Inconspicuous	Prominent
SEEDS		
Shape	Subreniform	Lenticular or subreniform
Surface	Viscid	Smooth or viscid

Barbieria has several morphological traits that are unique within the Clitoriinae. These include the imparipinnate leaves with a high leaflet num-

ber, subulate-acuminate apices of the stipules, bracts, bracteoles, and calyx lobes, the calyx with the upper two teeth free to near the base, the wings shorter than the other petals, the oblong-oblongeolate standard, and the sessile ovaries and fruits. These characteristics make *Barbieria* an aberrant member also from other genera of the Clitoriinae, and support its recognition as a separate genus.

Barbieria does have a lot of similarities with members of the Clitoriinae, including persistent stipules and stipels, appressed bracteoles, pseudo-racemes with flowers paired at nodes, resupinate flowers with clawed petals, naked calyx interior, and the constant prescence of micro-uncinate trichomes underlaying macrotrichomes. It would appear that the placement of *Barbieria* within the Clitoriinae by Lackey (1981) has merit.

KEY TO GENERA AND SUBGENERA IN THE CLITORIINAE

1. Calyx with dorsal lobes free to near base; standard elongate-oblong; wing petals shorter than the keel; bracts, bracteoles, stipules and calyx lobes subulate-acuminate; anthers white; leaflets 15–21; fruits turgid, strongly depressed between the seeds and subsessile; seeds viscid. **Barbieria**
1. Calyx with dorsal lobes connate below; standard broadly ovate to suborbicular; wing petals subequal to longer than the keel petals; bracts, bracteoles, stipules and calyx lobes acute to obtuse, non subulate-acuminate; anthers yellow; leaflets 3 or 1, rarely 5–11; fruits flat or prominently stipitate when depressed between the seeds; seeds smooth or occasionally viscid (*Clitoria* subg. *Neurocarpum*).
 2. Keel and wing petals subequal, each slightly shorter than the vexillum; anthers dimorphic, five dorsifixed, others basifixed on longer filaments; style weakly incurved from the near the base; calyx narrow infundibular (length ca 4–5 times the width). **Clitoriopsis**
 2. Keel shorter than wing petals, each much shorter than the vexillum; anthers uniform; style strongly incurved, broadly U-shaped, or J-L-shaped near the apex; calyx broadly infundibular to campanulate.
 3. Calyx campanulate; keel petals slightly shorter than wing petals; style strongly, gradually curved inward, broadly U-shaped or J-shaped; fruit and ovary subsessile.
 4. Style glabrous; legume valves ecostate; vexillary spur absent. **Periandra**
 4. Style pubescent, barbellate basally, less so above; legume valve cotate, with a prominent nerve or wing near the suture; vexillum spurred. **Centrosema**
 3. Calyx broadly infundibular (length ca 2–3 times width); keel petals much shorter than the wing petals; style geniculate (L-shaped), abruptly incurved; fruit and ovary stipitate, rarely subsessile. **Clitoria**
 5. Calyx subcoriaceous, striated; seeds large (7–16 mm diam.), lenticular; stipe (12–33 mm), staminal sheath (25–40 mm), ovary (10–20 mm), and petiolule (4–10 mm) elongated; inflorescence lignose, nodose, several to multi-flowered; leaflets larger (8–20 long × 3–23 cm wide). Subg. **Bractearia**

5. Calyx cartilaginous to subpellucid, 10-veined; seeds small (3×8 mm), subreniform to ovoid; stipe (1–14 mm), staminal sheath (10–23 mm), ovary (5–9 mm), and petiolule (1–5 mm, rarely 6–8 mm) shortened; inflorescence sublignose, usually 1–2-flowered, rarely few-several-flowered; leaflets smaller (1–8 long $\times$ 1–4 cm wide).
6. Legume flat, subsessile (stipe 1–4 mm), ecostate; seeds smooth, germination epigeal; calyx shrinking in fruit, subpellucid; cleistogamy absent; leaflets 5–11, rarely 3 and 1. Subg. **Clitoria**
6. Legume turgid, convex around seeds, stipitate (stipe 4–14 mm), costate or ecostate; seeds viscid, germination hypogeal; calyx persistent in size in fruit, subcartilaginous; cleistogamy present or absent; leaflets 3, rarely 3 and 1, or unifoliate. Subg. **Neurocarpum**

TAXONOMIC TREATMENT OF *BARBIERIA*

BARBIERIA DC., Prodr. 2:234. 1825. TYPE SPECIES: *B. pinnata* (Pers.) Baill.

Shrub, erect or apically scandent or trailing. Leaves alternate, imparipinnate, petiolate, stipulate, stipellate; leaflets numerous, opposite, entire; petiolules quadrate; stipules persistent, striate, subulate-acuminate; stipels persistent, 1-nerved, linear-subulate. Inflorescence axillary or terminal, pseudoracemose, few-flowered, long-pedunculate; pedicels paired at nodes. Bracts 4, striate, lance-subulate, pubescent adaxially; the inner pair often persistent, opposite and appressed to the pedicel; the outer pair narrower, between the pedicels, deciduous. Bracteoles paired at calyx base, lanceolate, subulate-acuminate, striate, pubescent adaxially. Flowers papilionaceous, resupinate, showy, red. Calyx narrowly infundibular, persistent in fruit, 5-lobed, lobes free, deltate to rapidly subulate above, subequal with ventral lobe slightly longer. Vexillum complicate, long-clawed, spurless, oblong-ob lanceolate; wings oblong, long-clawed, much shorter than the keel; keel long-clawed, elliptic-oblong, subequal to the vexillum. Stamens diadelphous, often persistent in fruit; vexillary stamen free nearly to base. Pistil enclosed within staminal sheath; ovary sessile, style linear, densely barbate, weakly incurved, weakly geniculate beneath stigma. Legume sessile, linear, straight, ecostate, enclosed at base by persistent calyx; valves strongly transverse-impressed between the seeds, spirally twisting upon dehiscence. Seeds smooth, transverse-oblong. ($x=10$).

A monotypic genus widespread in the neotropics, but apparently rare locally since collections in herbaria are comparatively few.

Barbieria pinnata (Pers.) Baill., Hist. Pl. 2:263. 1870. *Galactia pinnata* Pers., Syn. Pl. 2:302. 1807. *Clitoria pinnata* (Pers.) R.H. Smith & G.P. Lewis, Kew Bull. 46:320. 1991. TYPE: PUERTO RICO, M. Ledru s.n. (HOLOTYPE: L; ISOTYPE: P).

Clitoria polyphylla Poir., Lam. Encycl. Suppl. 2:300. 1811. *Barbieria polyphylla* (Poir.) DC., Mém. Légum. 242. 1825. TYPE: PUERTO RICO, M. Ledru s.n. (P).

Barbieria maynensis Poepp. & Endl., Nov. Gen. & Spec. 3:58, t.245. 1845. TYPE: Peru (orientalis). Crescit in sylvis primaevae ad flumen Huallaga versus Tocache et Yurimaguas, Julio ad Decembrem floret, *sine coll. & no.* [Poeppig coll.?)

Shrub 1–2.5 m, or a woody vine scandent 9–12 m or trailing; branches striate-terete, 1–6 mm diam., densely hirsute, trichomes to 2 mm long, reddish-brown becoming whitish with age; pubescence of micro-uncinate (hooked) trichomes common (vidi 20–30×) beneath macrotrichomes; pith continuous. *Leaves* imparipinnate; leaflets (9)13–21(25), oblong to elliptic-oblong to ovate-oblong, broadly acute to obtuse, mucronate (to 1 mm long), (1.5)2.5–6 cm long, 1–2.5 cm wide, upper surface bright to dark green, micro-uncinate pubescent (beneath sparse strigose macrotrichomes when young), lower surface pale, whitish to bluish-green, moderately to densely appressed-pilose; petioles 1–4 cm long, densely rufo-pilose; rachis quadrangular-terete, sulcate above, 5–16 cm long, internodes 0.5–2.5 cm long, micro-uncinate beneath rufo-pilose trichomes; petiolules rugose, dark-colored, rufo-pilose, 2 mm long; stipules narrowly deltate-lanceolate, 5–8-striate, subulate-acuminate, 7–12 mm long, 1.2–2 mm wide, pubescence micro-uncinate; stipels linear-subulate, 1-striate, (1.5)3–5 mm long, ca 0.2–0.8 mm wide, pubescence micro-uncinate. *Inflorescence* 4–16(24) cm long, flowering toward apex; peduncle 4–11 cm long, rufo-pilose; rachis internodes 1–3.5 cm long; pedicels 3–5 mm long in flower, 5–7 mm long in fruit. Bracts deltate-ovate, acute, 3–8 mm long, 0.5–1 mm wide, pubescence micro-uncinate. Bracteoles lanceolate, subulate-acuminate, dark greenish-yellow becoming strong reddish-orange, 7–11 mm long, 2–3 mm wide, pubescence ciliate and micro-uncinate. *Flowers* 4.5–6.0 cm long, red. Calyx dark, vivid red; tube 16–22 mm long, 3–5 mm wide at base expanding to 6–8 mm wide at throat, venation 20-striate, one vein extending into each lobe to its apex, one vein extending to each sinus, and three less conspicuous veins between these two; lobes deltate-ovate, subulate-acuminate, dorsal and lateral lobes 8–11 mm long, to 2 mm wide basally, ventral lobe 10–12 mm long. Standard brilliant to blood red, paler toward spotted center, blade oblong-ob lanceolate, 25–33 mm long, 14–17 mm wide; claw 21–24 mm long, 3–5 mm wide; wings red, blade oblong, flaring apically, 9–13 mm long, 3.5–6 mm wide; claw 26–33 mm; keel red, blade elliptic-oblong, weakly falcate, 17–23 mm long, 2.5–5 mm wide; claw 26–34 mm long. Staminal sheath white, 36–44 mm long, free filaments filiform, (4)6–8 mm long; anthers white, lanceolate, 0.9–1.2 mm long. Gynophore lacking or to 0.5 mm long; ovary linear, 8–11 mm long, 1–1.2 mm wide, pubescence dense, trichomes white, to 2 mm long, ascending-appressed; style (29)38–43 mm long, exerted beyond stamens, flattened, bearded lengthwise, geniculate 5–6 mm from distal end; stigma capitate. Legume

pale green becoming brown, subsessile, linear, straight, ecostate, enclosed at base by persistent calyx; stipe 0.5–1 mm long; valves puberulent-hirsute, strongly transverse-impressed between the seeds, 36–55 mm long, 4–6 mm wide, spirally twisting upon dehiscence 0.5–1.5 turns; beak inconspicuous, 1–2 mm long. Seeds 4–9 per pod, dull dark brown to black, viscid, transverse-oblong, $2.2\text{--}3 \times 4\text{--}6 \times 0.6\text{--}1.5$ mm. ($x = 10$).

Illustrations.—De Candolle (1826, tab. 39), Poeppig (1845, plate 264), and White (1980, fig. 6) provided excellent line drawings of vegetative and reproductive structures.

Vernacular names.—Peru: puspo poroto huasca (*Vigo* 8307), pusporota huasca (*Schunke* 12412).

Economic uses.—"One of the best ground cover crops" (*Schipp* 1108). Excellent potential as a climbing ornamental.

Phenology.—Plant vouchers have been collected with flowers (March) and fruits from April through December.

Habitat.—Moist soils in secondary growth, roadsides, riverine forests, forests edges or open areas with abundant sun. Elevation 390–1000 m.

Distribution.—Southern Mexico south to Peru and west to Venezuela and Brazil, and in the Caribbean. Collectors often noted that the plant rarely was observed in the area sampled.

Specimens examined ["g-" = gift specimen from institution cited]: CENTRAL AMERICA. **BELIZE (BRITISH HONDURAS)**. Río Grande, *Schipp* 1108 (F,MICH,MO,NY). STANN CREEK: 17 mi section, Stann Creek Valley, *Gentle* 9255 (F,LL,MEXU, MICH,NY). **COSTA RICA**. *Larkowski* 1261 (F). PUNTARENAS: Helechales, Potrero Grande, Buenos Aires, *Gómez-Laurito* 10839 (F); Cabugra, Buenos Aires, *Ocampo* 2424 (CR); vic. Buenos Aires, *Pittier* 4714 (P); Terruba, Buenos Aires, *Poveda* 869 (F); Buenos Aires de Puntarenas, *Zamora et al.* 869 (F); Buenas Aires de Puntarenas, *Zamora* 1186 (CR,F). SAN JOSE: Helechales de San Isidro del General, *León* 1025 (CR); vic. El General, *Skutch* 2263 (MO,NY); Río Convento near Panamerican Hwy, El General Valley, *Williams et al.* 28704 (CR,F,NY); Valle de El General, *Yeilding* 246 (F); San Isidro de El General, El Pilar de Cajón, *Zamora et al.* 1520 (CR). **GUATEMALA**. ALTA VERAPAZ: between Samanzana & Candelaria via Seboquil, *Steyermark* 45101 (F,NY); Cubilquitz, *Tuerckheim* 7845 (F,M,MO,NY,P). **MEXICO**. Río Piedras, *Hioram s.n.* (P). NAYARIT: Sierra San Pedro Nolasco, *Jurgensen* 780 (MO). OAXACA: *Galeotti* 3431 (P); Comaltepec, *Liebmman* 4654 (F).

CARIBBEAN. CUBA. *Wright* 2302 (MO). ISLE OF PINES: vic. San Pedro, *Britton et al.* 15105 (F,MO). DOMINICAN REPUBLIC. *Wright et al.* 89 (F). LA VEGA: vic. Piedra Blanca, *Allard* 13483 (MO); vic. Piedra Blanca, *Allard* 17062 (F); Cordillera Central, Jarabacoa toward Buenavista, *Ekman* 14189 (MO). MONTE CRISTI: Leonor, dist. Sabaneta, *Valeur* 76 (F-2 sheets, MO). SAN CRISTOBAL: near El Cacao, San Cristóbal, *Liogier* 17767 (F). SANTO DOMINGO: vic. Ciudad Trujillo, *Allard* 13338 (US); Cordillera Central, Villa Altagracia, *Ekman* 11179 (F). HAITI. ARTIBONITE: vic. Kalacroix, section Dessalines, *Leonard* 7900 (F). NORD: trail to Citadel in vic. Dondon, *Leonard* 8642 (MO). PUERTO RICO. Aquada ad Piedra Blanca, *Sintenis* 5710 (F,MO). AGUADILLA. La Juanita near Las Marías, *Britton et al.* 3939 (F,MO,US); vic. Maricao, *Britton & Cowell* 4092 (F,US). HUMACAO. PR 966 near km 4.7, E of El Verde, Sierra de Luquillo, *Burch* 3203 (MO,TENN); Lares ad

Palma Llanos, *Sintenis* 5942 (F,MO). MAYAGÜEZ. near Mayagüez, *Holm* 27 (MO). SAN JUAN. Río Piedras, *Otero* 325 (MO).

SOUTH AMERICA. BOLIVIA. Guanai, Tipuani, *Bang* 1363 (F,MO-2 sheets,US); Río Junsay (?), *Kuntze s.n.* (F,US); Guanai, *Rusby* 2356 (F,MO-2 sheets). **BRAZIL.** AMAZONAS: São Paulo de Olivença, *Ducke* 565 (F,MO); Río Solimões, beside Estrada Bom Fim, São Paulo de Olivença, *Lleras et al.* P17342 (MO); Lago de Tefé, opposite Tefé, *Lleras et al.* P17490 (MO); Mun. Humaitá, estrada Humaitá-Pôrto Velho km 38, *Teixeira et al.* 270 (MO,US). GOIÁS: ca. 17 km S of Goiás Velho, 6 km NE of Mossamedes, Serra Dourada, *Anderson* 10141 (MO). MATO GROSSO: Santa Anna de Chapada (= dos Guimarães), *Regnell* 3316a (F). PARÁ: Mun. Itaituba, estrada Santarém-Cuiabá, BR-163 km 842, Serra do Cachimbo, *Silva* 250 (MO). RONDONIA: Mun. de Colorado de Oeste, BR 364, Pôrto Velho-Cuiabá, km 20, *Cid et al.* 4367 (MO,US). **COLOMBIA.** ANTIOQUIA: Mpio. San Rafael, 3.1 km E of San Rafael along Guatope-San Rafael Rd, *Brant & Roldán* 1514 (g-MO). BOYACA: El Umbo, 130 m NW of Bogotá, *Laurence* 488 (F,MO,US). META: Los Llanos, Villavicencio, *Haught* 2457 (F). VAUPÉS: Cano Grande y San José del Guaviare, *Cuatrecasas* 7378 (F); Mitú & vic., Urania, *Zarucchi* 2249 (MO). **PERU.** AMAZONAS: Mirana, *Woytkowski* 5648 (MO). CUZCO: Paucartambo, Pileopata, Izguierda, *Vargas* 11642 (MO); Casnipala, *Weberbauer* 6951 (F,F-frag.). HUÁNUCO: Monzón, *Woytkowski* 5029 (MO). JUNIN: La Merced, *Killip & Smith* 23758 (F); Río Paucartambo Valley near Perené Bridge, *Killip & Smith* 25367 (F). LORETO: prov. Coronel Portillo, Bosque Nac. de van Humboldt, Ucayali, km 86 Pucallpa-Tingo Mariá rd, *Gentry & Salazar* 29440 (MO); Yurimaguas, Río Huallaga, *Killip & Smith* 27941 (F); Balsapuerto, *Klug* 2978 (F,MO); Balsapuerto, *Klug* 3095 (F,MO); alto Amazonas, Lagunas, trail to Argentina, *McDaniel & Rimachi* 16433 (F,MO); alto Amazonas, Yurimaguas, Carretera del Caserio de Munich, *Rimachi* 3013 (F,MO,TENN); 3 km S of Yurimaguas, *Straw* 2416 (US). PASCO: Oxapampa prov., Serrania de San Matias E of Loma Linda, *Gentry et al.* 42000 (g-MO); prov. Oxapampa, Iscozacín, *Smith* 2080 (DUKE,MO). SAN MARTIN: W of Huicte, *Schunke* 6524 (F). SAN MARTIN (MARISCAL CACERES): Dtto Tocache Nuevo, Pucayacu nr Tocache Nuevo, *Plowman & Schunke* 7497 (F); Dtto. Tocache Nuevo, Quebrada de Ishichimi (Fundo Retiro), *Schunke* 3913 (F,MO); Quebrada de Huaquisha (Río Huallaga), *Vigo* 7155 (MO); Almendras, camino a Pueblo Viejo, *Vigo* 8186 (MO); Dtto. Tocache Nuevo, Fundo Jeroglífico, del Sr. Luis Ludena (Quebrada Ishichimi), *Vigo* 8307 (MO); dtto. Tocache Nuevo, Quebrada Ishichimi, cerca al Fundo del San Luis Ludena, *Schunke* 12412 (F). **VENEZUELA.** BARINAS: 0.5 km NW of Barinitas, *Steyermark & Wiehler* 106605 (F,MO). BOLIVAR: Dist. Roscio, "El Abismo," Río El Samay, affluente Icabaru, *Holst & Liesner* 2365 (F,MO,NY); km 316 S of El Dorado, 2 km S of Santa Elena de Uairén, *Steyermark* 111328 (F,US-2,VEN). SUCRE. Dist. Benítez, entre Río Frió y Caño Yaguaíma, *Benítez* 2908 (MO); Dist. Benítez, Serranía de la Paloma, 28 km SE of Ajies rd to Guariquen, *Steyermark et al.* 121405 (MO).

EXSICCATAE

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FUERTESIMALVA, A NEW GENUS OF NEOTROPICAL MALVACEAE

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ABSTRACT

Urocarpidium sect. *Urocarpidium* is shown to be synonymous with the genus *Tarasa*, and *Urocarpidium* sect. *Anurum* is generically distinct. The latter is redescribed in generic rank and given the name *Fuertesimalva*. Fourteen new combinations are made.

RESUMEN

Urocarpidium sect. *Urocarpidium* es un sinónimo del género *Tarasa*, y *Urocarpidium* sect. *Anurum* es considerado como un género distinto. Este último se redescrive en el rango generico con el nombre de *Fuertesimalva*. Se proponen catorce combinaciones nuevas.

The genus *Urocarpidium* was established by Ulbrich (1916) with the single species *U. albiflorum* Ulbrich. It was subsequently enlarged to include ten other species (Krapovickas 1954a), and ultimately a total of 14 species (Krapovickas 1970). The same number of species is recognized in the following enumeration, although with some nomenclatural changes (e.g., Fryxell & Krapovickas 1990; Krapovickas & Fryxell 1993) and the addition of more recently described species. Krapovickas (1954a) divided the genus into two sections, sect. *Urocarpidium* containing only the type species, and sect. *Anurum* Krapov., including the remaining species. This interpretation has been followed by most subsequent authors (e.g., Hutchinson 1967).

The etymology of the generic name *Urocarpidium* is considered problematical inasmuch as Ulbrich did not state his intention in proposing it. A reconsideration of its derivation led to a reconsideration of its taxonomy. Fryxell (1988) cited the roots of the name as the German “ur” (primitive) and the Latin “carpidium” from the Greek “karpos” (fruit) with a diminutive ending, thus meaning primitive mericarp. This is a plausible derivation, if one considers the relatively unornamented fruits that are typical of most of the species. However, an alternative derivation (Fuertes 1989) is from the Greek “ouro” (tail) plus “carpidium,” meaning tailed (or aristate) mericarp. This interpretation was earlier rejected (Fryxell 1988) because the mericarps typical of these plants are not tailed or aristate. However, the question concerns the nature of the mericarps of the type species, *U. albiflorum*, the only species that Ulbrich knew when he described and named

the genus. The mericarp of this species was described by Ulbrich (1916) as “apice cauda longissima ad fere 8 mm longa ciliata munita” and was illustrated by Krapovickas (1954a) from an isotype specimen (PERU, mountains near Chosica, *A. Weberbauer* 5326, ISOTYPE: GH). A reconsideration of the mericarp morphology of *U. albiflorum* makes it clear that this species has aristate, pubescent mericarps and thus belongs in the genus *Tarasa* Phil. (and incidentally that the derivation given by Fuertes is correct). In fact, the mericarps of *U. albiflorum* (cf. Krapovickas 1954a, fig. 2A) conform closely to those of *Tarasa operculata* (Cav.) Krapov. (cf. Krapovickas 1954b, fig. 2A), and the former should perhaps be reduced to a synonym of the latter. In any case, *Urocarpidium* is to be treated as a synonym of *Tarasa*, and the remaining species, which are usually placed in *Urocarpidium*, form a natural genus that is lacking a name. It is the purpose of this note to describe the new genus and to supply a new name and make the necessary new combinations.

Fuertesimalva Fryxell, gen. nov. TYPE: *Fuertesimalva limensis* (L.) Fryxell ($\equiv$ *Malva limensis* L.)

Urocarpidium Ulbr. sect. *Anurum* Krapov. Darwiniana 10:614. 1954. LECTOTYPE, here designated: *Urocarpidium limense* (L.) Krapov. ($\equiv$ *Malva limensis* L.).

Herbae stellato-pubescentes, cymis axillaribus scorpioideis et corollis purpurascentibus et fructibus glabris, mericarpiis singularis plus minusve hippocrepiformibus, necnon muticis atque irregulariter transversim rugatis, rugis paucis.

Annual or perennial herbs, ascending or erect, with stellate pubescence. Leaves petiolate, the blades ovate or orbicular, usually palmately lobed or parted, crenate or dentate, the upper surface sometimes with appressed simple hairs. Flowers sometimes solitary, usually in axillary scorpioid cymes; involucl of 2 or 3 filiform bractlets; calyx stellate-pubescent, (4–) 5-lobed; corolla purplish (sometimes white), shorter than to slightly longer than the calyx; androecium included, the column glabrous or pubescent, filamentiferous at apex, the anthers sometimes purple, few (sometimes only 5); styles 5–16, the stigmas capitate. Fruits schizocarpic, oblate, glabrous; mericarps 5–16, indehiscent, horseshoe-shaped, with irregular transverse ridges (these sometimes interlocking in the fruit between adjacent mericarps), sometimes with a small endoglossum; seeds solitary, glabrous.

Fuertesimalva is an Andean genus (Argentina and Chile to Colombia and Venezuela), with two species (*F. jacens* and *F. limensis*) found disjunctly in Mexico, usually from relatively high elevations (generally 1000–3800 m), but from much lower elevations (100–600 m) for *F. sanambrosiana* and *F. peruviana*. Keys to the species are found in Krapovickas (1954a, 1970), and a revised key is presented below. Chromosome numbers have been reported for several species (summarized by Krapovickas 1967, Tables 1 and 2, pp. 29, 34), with counts of $2n = 10, 20$, and 30 .

Fuertesimalva pertains to the *Sphaeralcea* alliance, i.e. those genera characterized by a base chromosome number of $x = 5$. Within this group it is one of the few genera characterized by axillary scorpioid inflorescences, which include *Tarasa* and, to a more limited extent, the genera *Monteiroa* and *Sphaeralcea*, the inflorescences of which conform to this pattern only imperfectly. The genera *Fuertesimalva* and *Tarasa* are very similar in leaf morphology and general aspect (as is evident from the plates published by Krapovickas 1954a, pl. 1–8), but are strikingly different in fruit morphology. The mericarps of *Fuertesimalva* are horseshoe-shaped, glabrous, and with characteristic transverse ridges or excrescences dorsally, in a pattern unlike that found in any other malvaceous genus. The mericarps of *Tarasa*, by contrast, are apically aristate, notably pubescent, and laterally reticulate, showing a superficial similarity to mericarps of *Sphaeralcea*. In addition, the two genera differ in pubescence characters, especially clearly presented in the case of calyx pubescence. *Fuertesimalva* pubescence is stellate (or sometimes with simple hairs) whereas that of *Tarasa* is commonly stipitate, with darkly pigmented stipes.

The results of cpDNA analysis by La Duke & Doebley (1995) show that *Urocarpidium* and *Tarasa* are not closely allied, in spite of sharing a common base chromosome number and a similar general aspect.

KEY TO THE SPECIES OF *FUERTESIMALVA*

1. Anthers 5(–7); flowers solitary or in few-flowered axillary inflorescences.
 2. Flowers always solitary.
 3. Carpels 5, the mericarps 1.5×1 mm; calyx and corolla pentamerous (Argentina). **F. pentacocca**
 3. Carpels 7–10, the mericarps 1.3×1.3 mm; petals often 3, the calyx usually 4-lobed [cf. Eliasson 1970] (Galápagos). **F. insularis**
 2. Flowers solitary or in few-flowered axillary inflorescences; carpels ca. 8, the mericarps 1.5×1.5 mm or larger (Argentina). **F. pentandra**
1. Anthers 10 or more; flowers generally in axillary scorpioid cymes.
 4. Stipules 5–10(–14) mm long, broadly ovate or falcate, ca. 5 mm wide; foliage subglabrous; carpels 12–15.
 5. Flowers sessile; calyx hirsute (Peru, Chile). **F. chilensis**
 5. Flowers pedicellate, the pedicels 2–3(–8) mm long; calyx with 1 or 2 setae (1.5 mm long) at tip of each lobe, otherwise glabrous (Peru). ... **F. stipulata**
 4. Stipules 2–6 mm long, linear-lanceolate, 0.5–2.5 mm wide; foliage generally pubescent; carpels 7–16.
 6. Petals 10 mm long; calyx 7–8 mm long, deeply divided, the lobes 6×2 mm; carpels 8–10; leaves basally truncate, unlobed (Peru). **F. leptocalyx**
 6. Petals 2–4(–7) mm long; calyx 4–6 mm long, ca. half-divided, the lobes shorter and broader; carpels 7–16; leaves often basally cordate, often palmately lobed.
 7. Mericarps 3×3 mm, ca. 10 (Peru). **F. pennellii**
 7. Mericarps usually 2.5×2.5 mm or smaller (or if larger, then only 8), 8–16.

- 8. Carpels 7–10; inflorescences 2–6-flowered.
 - 9. Inflorescences 2–3-flowered; mericarps 4.5×2.8 mm, apically acute (Peru). *F. corniculata*
 - 9. Inflorescences 2–6-flowered; mericarps 2.5×2.5 mm or smaller.
 - 10. Mericarps 1.5×1.5 mm (Colombia, Ecuador). *F. killipii*
 - 10. Mericarps 2×2 mm.
 - 11. Inflorescences subequal to the subtending leaf (Peru, Bolivia, Argentina). *F. echinata*
 - 11. Inflorescences generally shorter than the subtending petiole (Mexico). *F. jacens*
- 8. Carpels more than 10; inflorescences often with 10 flowers or more, often equalling or exceeding the subtending leaf.
 - 12. Mericarps lacking an endoglossum; plants of relatively high elevation (1400–3200 m) (Mexico, Venezuela, Colombia, Ecuador, Peru). *F. limensis*
 - 12. Mericarps with a small internal projection (endoglossum); plants of relatively low elevation (100–600 m).
 - 13. Mericarps black at maturity, 1.5–2 mm long (Peru, Chile). *F. peruviana*
 - 13. Mericarps pale brown at maturity, 1.2–1.5 mm long (Chile: Islas Desaventuradas). *F. sanambrosiana*

1. *Fuertesimalva chilensis* (A. Braun & Bouché) Fryxell, comb. nov.

Malva chilensis A. Braun & Bouché, Ind. Sem. Hort. Berol. 1. 1857. *Urocarpidium chilense* (A. Braun & Bouché) Krapov., Darwiniana 10:619. 1954. TYPE: CHILE, ex hort. Berolinensis (B as photo F-9322).

Malva scorpioides Turcz. Bull. Soc. Imp. Naturalistes Moscou 36:562. 1863. *Malvastrum peruvianum* var. *scorpioides* (Turcz.) E. G. Baker, J. Bot. 29:168. 1891. TYPE: PERU. LIMA: valley of Lima, A. Matthews 1006 (ISOTYPES: K, OXF).

Malvastrum hinkleyorum I. M. Johnst., Contr. Gray Herb. n.s. 70:73. 1924. TYPE: PERU. near Arequipa, 2100 m, Mar 1920, F. E. Hinkley & Mrs. Hinkley 43 (HOLOTYPE: GH; ISOTYPE: US).

Distribution.—Peru and Chile; 2100–2800 m elevation (0–3000 m fide Brako & Zarucchi 1993).

Illustrations.—Krapovickas (1954a, fig. 2F, pl. 3).

2. *Fuertesimalva corniculata* (Krapov.) Fryxell, comb. nov.

Urocarpidium corniculatum Krapov., Bonplandia 3: 67. 1970. TYPE: PERU. LIMA: Matucana (Valle de Rimac), 1000 m, 3 Apr 1967, M. Chanco 25 (HOLOTYPE: CTES).

Distribution.—Peru (Lima); 1000 m elevation (500–3000 m fide Brako & Zarucchi 1993).

Illustrations.—Krapovickas (1970, fig. 3A-B).

3. *Fuertesimalva echinata* (C. Presl) Fryxell, comb. nov.

Malva echinata C. Presl, Reliq. Haenk. 2:122. 1835. *Urocarpidium echinatum* (C. Presl) Krapov. & Fryxell, Bonplandia 7:58. 1993. TYPE: PERU. in Cordilleris Peruviae, T. Haenke s.n. (LECTOTYPE, designated by Krapovickas & Fryxell, loc. cit.: PR; ISOTYPE: PR).

Malvastrum shepardae I. M. Johnst. Contr. Gray Herb. n.s. 70:75. 1924. *Urocarpidium shepardae* (I. M. Johnst.) Krapov. Darwiniana 10:621. 1954. TYPE: PERU. PUNO: vicinity of Lake Titicaca, Dec. 1919, *R. S. Shepard* 123 (HOLOTYPE: GH).

Distribution.—Peru, Bolivia, Argentina (Salta, Tucumán); 2000–3800 m elevation (0–4500 m fide Brako & Zarucchi 1993).

Illustrations.—Krapovickas (1954a, fig. 2E, pl. 4).

4. *Fuertesimalva insularis* (Kearney) Fryxell, comb. nov.

Malvastrum insulare Kearney, Leaf. W. Bot. 6:167. 1952. *Urocarpidium insulare* (Kearney) Krapov. Darwiniana 10:631. 1954. TYPE: ECUADOR. GALAPAGOS ISLANDS: Albemarle (Isabella) Island, summit of Tagus Cove Mountain, 26 May 1932, *J. T. Howell* 9570 (HOLOTYPE: CAS).

Distribution.—Ecuador (Islas Galápagos); 1500–1600 m elevation (cf. Eliasson 1970).

Illustrations.—Bates (1971, fig. 190), Eliasson (1970, fig. 2), Krapovickas (1954a, fig. 2L).

5. *Fuertesimalva jacens* (S. Watson) Fryxell, comb. nov.

Malvastrum jacens S. Watson, Proc. Amer. Acad. Arts 21:417. 1886. *Urocarpidium jacens* (S. Watson) Krapov. Darwiniana 10:267. 1954. TYPE: MEXICO. CHIHUAHUA: Norogachic, 150 mi N of Batopilas, Aug–Nov 1885, *E. Palmer* 430 (LECTOTYPE, designated by Hill 1982: GH; ISOTYPES: K, US).

Malvastrum jacens var. *palmatifidum* Hochr., Annuaire Conserv. Jard. Bot. Genève 6:32. 1902. *Urocarpidium palmatifidum* (Hochr.) Krapov. Darwiniana 10:623. 1954. TYPE: MEXICO. CHIHUAHUA: in Sierra Madre, 2 Oct 1988, *C. G. Pringle* 1574 (HOLOTYPE: G; ISOTYPES: BM, BR, G, UC).

Distribution.—Mexico (Chihuahua to Chiapas; see map in Fryxell 1988, fig. 112); 2300–3000 m elevation.

Illustrations.—Fryxell (1988, fig. 113; 1992a, fig. 25), Krapovickas (1954a, fig. 2G–H).

6. *Fuertesimalva killipii* (Krapov.) Fryxell, comb. nov.

Urocarpidium killipii Krapov., Darwiniana 10:626. 1954. TYPE: COLOMBIA. SANTANDER: vicinity of Surata, 1600–1800 m, 4–10 Jan 1927, *E. P. Killip* & *A. C. Smith* 16757 (HOLOTYPE: US; ISOTYPES: GH, NY).

Distribution.—Colombia (Santander) and Ecuador (Chimborazo, Imbabura, Pichincha, Tungurahua); 1600–2200 m elevation.

Illustrations.—Krapovickas (1954a, fig. 2K, fig. 3G–I, pl. 6).

7. *Fuertesimalva leptocalyx* (Krapov.) Fryxell, comb. nov.

Urocarpidium leptocalyx Krapov., Kurtziana 2:118. 1965. TYPE: PERU. ANCASH: prov. Santa Ana, 1700 m, 10 May 1960, *A. Alza* 11 (HOLOTYPE: LIL).

Distribution.—Peru (Ancash, Cajamarca); 1700–2100 m elevation.

Illustration.—Krapovickas (1965, fig. 3D–G).

8. *Fuertesimalva limensis* (L.) Fryxell, comb. nov.

Malva limensis L., Cent. Pl. 2:27. 1756; Amoen. Acad. 4:325. 1759. *Malvastrum limense* (L.) Ball, J. Linn. Soc., Bot. 22:32. 1885. *Malvastrum peruvianum* var. *limense* (L.) E. G. Baker, J. Bot. 29:168. 1891. *Urocarpidium limense* (L.) Krapov., Kurtziana 4:33. 1967. TYPE: "limensis" (HOLOTYPE: LINN-870.6).

Malva costata C. Presl, Reliq. Haenk. 2:123. 1835. TYPE: PERU. in collibus Cordillerum Peruviae, *T. Haenke s.n.* (HOLOTYPE: PR).

Distribution.—Mexico (Durango to Morelos and Veracruz; see map in Fryxell 1988, fig. 112), Venezuela, Colombia, Ecuador and Peru; 1400–3500 m elevation (cf. Brako & Zarucchi 1993).

Illustrations.—Fryxell (1992a, fig. 16; 1993, p. 166), Fuertes (1989, pls. 28, 29*, 30).

9. *Fuertesimalva pennellii* (Ulbrich) Fryxell, comb. nov.

Malvastrum pennellii Ulbrich, Notizbl. Bot. Gart. Mus. Berlin-Dahlem 11:524. 1932. TYPE: PERU. AREQUIPA: Arequipa, 2600–2700 m, 7–16 Apr 1925, *F. W. Pennell* 13206 (HOLOTYPE: F). Hill (1982, p. 398) notes that the holotype is missing at F. No isotypes are known, but one should be sought at PH, where Pennell's original herbarium is preserved.

Urocarpidium macrocarpum Krapov., Darwiniana 10:624. 1954. TYPE: PERU. LIMA: Canta, 2800–2900 m, 11–19 Jun 1925, *F. W. Pennell* 14589 (HOLOTYPE: US; ISOTYPES: GH, S).

Distribution.—Peru (Arequipa, Lima); 2500–2900 m elevation (0–3500 m fide Brako & Zarucchi 1993).

Illustrations.—Krapovickas (1954a, fig. 2J, fig. 3D-F, pl. 5).

10. *Fuertesimalva pentacocca* (Krapov.) Fryxell, comb. nov.

Urocarpidium pentacoccum Krapov., Bonplandia 3:69. 1970. TYPE: ARGENTINA. CATAMARCA. dep. Ambato, Sierra de Ambato, desde El Rodeo hacia el Cerro Manchado, 2900–3100 m, 23–25 Feb 1967, *A. T. Hunziker* 19223 (HOLOTYPE: CTES).

Distribution.—Argentina (Catamarca); 2900–3100 m elevation.

Illustrations.—Krapovickas (1970, fig. 3C-E).

11. *Fuertesimalva pentandra* (Schumann) Fryxell, comb. nov.

Malvastrum pentandrum Schumann, Martius Fl. Bras. 12(3):273. 1892. *Urocarpidium pentandrum* (Schumann) Krapov. Darwiniana 10:362. 1954. TYPE: ARGENTINA. CATAMARCA: Cuesta de Muschaca, *F. Schickendantz* 305 (LECTOTYPE, chosen by Krapovickas 1954a: B as photo F-9321; ISOLECTOTYPE: CORD).

Malvastrum catamarcense I.M. Johnst., Contr. Gray Herb. 70:75. 1924. TYPE: ARGENTINA. CATAMARCA: dep. Andalgalá, El Candado, 2 Sep 1916, *P. Jörgensen* 1388 (HOLOTYPE: GH; ISOTYPES: MO, US).

Distribution.—Argentina (Catamarca).

Illustrations.—Krapovickas (1954a, fig. 2I, pl. 8).

12. *Fuertesimalva peruviana* (L.) Fryxell, comb. nov.

Malva peruviana L., Sp. Pl. 688. 1753. *Malvastrum peruvianum* (L.) A. Gray, Bot. U.S. Explor. Exp. 1:146. 1854. *Malveopsis peruviana* (L.) O. Kuntze, Revis. Gen. Pl. 3(2):21. 1898. *Urocarpidium peruvianum* (L.) Krapov., Darwiniana 10:269. 1954. TYPE: Hortus Upsaliensis, seeds from Jussieu (HOLOTYPE: LINN-870.5; ISOTYPE: P-JU).

Malva mathewsii Turcz., Bull. Soc. Imp. Naturalistes Moscou 36:563. 1863. *Urocarpidium mathewsii* (Turcz.) Krapov., Darwiniana 10:616. 1954. TYPE: PERU. LIMA: Valley of Lima, A. Matthews 402 (ISOTYPE: K).

Distribution.—Coastal deserts of Peru and Chile; 100–600 m elevation (0–3000 m fide Brako & Zarucchi 1993).

Illustrations.—Díaz (1969, fig. 5), Krapovickas (1954a, fig. 2B-D, fig. 3A-C, pls. 2, 7).

13. *Fuertesimalva sanambrosiana* (D.M. Bates) Fryxell, comb. nov.

Urocarpidium sanambrosianum D.M. Bates, Gentes Herb. 9:383. 1965. TYPE: CHILE. ISLAS DESAVENTURADAS: San Ambrosio, above Punta Potalas, 250 m, 5 Dec 1960, G. Kuschel 7 (HOLOTYPE: K).

Distribution.—Chile (Islas Desaventuradas); “above 250 m” elevation.

Illustration.—Bates (1965, fig. 280).

14. *Fuertesimalva stipulata* (Fryxell) Fryxell, comb. nov.

Urocarpidium stipulatum Fryxell, Contr. Univ. Michigan Herb. 17:168. 1990. TYPE: PERU. CAJAMARCA: Las Cherimoyas, above San Benito (NE of Trujillo), 1400 m, 2 Apr 1987, C.L. Burandt, D.J. Keil & A. Sagástegui 2333 (HOLOTYPE: F; ISOTYPE: NY).

Distribution.—Peru (Cajamarca); 1400 m elevation.

Illustration.—Fryxell (1990, fig. 4).

ACKNOWLEDGMENTS

I am grateful to Javier Fuertes for insightful conversations on both the taxonomy and the etymology of *Urocarpidium*. Since these conversations led to the reduction of the name to synonymy, I feel it is appropriate to propose the new name *Fuertesimalva* in his honor, compounded from his surname plus the root of the family name Malvaceae, meaning “Fuertes’ mallow,” in recognition of his continuing contributions to our knowledge of this family.

I also thank L.J. Dorr and an anonymous reviewer for comments that materially improved this manuscript. Support from NSF Grant DEB 9420233 to John La Duke and Paul Fryxell is greatly appreciated.

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ROBINSONECIO (ASTERACEAE: SENECEONEAE) A NEW GENUS FROM MEXICO AND GUATEMALA

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ABSTRACT

Robinsonecio, gen. nov., is a distinctive genus of two species from high elevations in Mexico and Guatemala. The plants are subscapose herbs with ovate to lanceolate or spatulate basal leaves and tussilaginoïd microcharacters. Two new combinations are proposed: *Robinsonecio gerberifolius* (Sch.Bip.) T.M. Barkley & J.P. Janovec, and *Robinsonecio porphyresthes* (T.M. Barkley) T.M. Barkley & J.P. Janovec.

RESUMEN

Robinsonecio, gen. nov., es un género con dos especies que viven en lugares elevados de México y Guatemala. Las plantas son herbáceas, subescaposas, con hojas basales de ovadas a lanceoladas o espatuladas y microcaracteres tussilaginoïdes. Se proponen dos nuevas combinaciones: *Robinsonecio gerberifolius* (Sch.Bip.) T.M. Barkley & J.P. Janovec, y *Robinsonecio porphyresthes* (T.M. Barkley) T.M. Barkley & J.P. Janovec.

A combination of new information and revised taxonomic theory has led to the notions that the traditional, encompassing concept of the super-genus *Senecio* is no longer tenable and that instead, numerous segregate genera are justified. The relevant thinking was presented in a series of papers by C. Jeffrey, B. Nordenstam, H. Robinson, and others, and it is summarized in the monumental review of the Asteraceae by Bremer (1994, q.v. for references). A catalog and justification of the segregate genera for Mexico and Central America are presented by Barkley et al. (in press). Our studies have shown that the Mesoamerican *Senecio gerberifolius* and *S. porphyresthes* clearly are related to each other but that they do not belong to any of the currently recognized segregate genera. Therefore, the purpose of this paper is to erect a new genus, *Robinsonecio*, to accomodate these two species.

The tribe *Senecioneae* includes two phyletic lineages that are recognized formally as the subtribes *Senecioninae* Dumortier and the *Tussilagininae* Dumortier, or the "senecionoids" and "tussilaginoids." The latter lineage was known in the older literature as the "tephroseroids" or the "cacalioids." Species that were referred to *Senecio*, s.l., in the traditional, super-genus sense are found in each of these phyletic lineages, i.e., "Senecio, s.l." is clearly polyphyletic (Barkley et al., in press; Bremer 1994). A third subtribe,

the distinctive *Blennospermatinae* Rydb., includes no species referable to *Senecio*, s.l., and its taxonomy is not relevant to this paper.

The senecionoid lineage is characterized by having style branches with separate stigmatic lines, the upper ends of the stamen filaments with swollen collars ("balusterform"), the anthers often with distinctive thickenings in the lateral walls of the endothelial cells ("radial" thickenings), and chromosome numbers based on $x = 10$ or 20 or numbers derived therefrom (including 22 or 23). In the tussilaginoid lineage, the stigmatic surface is entire or nearly so across the inner face of the style branch, the filaments are cylindrical and not typically swollen, the anthers often have distinctive thickenings in the transverse (end) walls of the endothelial cells ("polarized" thickenings), and the chromosome numbers are based mostly on $x = 30$ or numbers derived therefrom, including numbers down to $n = 24$ (Bremer 1994).

The species that we call *Robinsonecio gerberifolius* was among the herbaceous senecios of the informal assemblage "*Lugentes*" in the scheme of Barkley (1985), which recognized *Senecio*, s.l., as a single, encompassing genus. Its inclusion there merely reflected superficial similarity, but the description of the segregate *Senecio* (*Robinsonecio*) *porphyresthes* noted that the two species were different from the other members of the "*Lugentes*" assemblage (Barkley 1989).

Specimens were borrowed for study (cited with the species descriptions below) and slides made to observe the microcharacters, using the techniques developed by Dr. H. Robinson of the Smithsonian Institution (pers. comm.). Slides were made for *R. gerberifolius* from the collections *Beaman* 2535 (GH) and *Morales A.* 164 (WIS) and for *R. porphyresthes* from *Stanford et al.* 679 (NY). The permanent slides are deposited in herb. KSC.

The slides indicate that both *Robinsonecio gerberifolius* and *R. porphyresthes* have the entire stigmatic areas and cylindrical stamen filaments of the tussilaginoid lineage. In addition, *R. gerberifolius* has a chromosome number of $n = 30$, vouchered by: *Beaman* 1948 (Stoutamire & Beaman 1960) and it has "polarized" thickenings in the endothelial cells of the anther. The chromosome number for *R. porphyresthes* is unknown, and it seems to have radial thickenings in the endothelial cells, but in our experience, this character is rather variable. The achenes of *R. gerberifolius* have a pronounced and perhaps a distinctive carpodium; the achenes in-hand for *R. porphyresthes* are immature, and so the nature of the carpodium is unknown. The two species of *Robinsonecio* resemble each other in gross aspect and habitat and are unlike any other species of the tussilaginoid lineage. The species of the "*Lugentes*" group of *Senecio* are typically senecionoid in microcharacters and chromosome numbers and are comfortably similar to each other in gross aspect.

Robinsonecio is distinctive in that it is the only tussilaginoid segregate of

Senecio, s.l., that consists of subscapose herbs with leaf blades ovate to spatulate and tapering to a winged petiole, and which has radiate heads with yellow corollas. *Robinsonecio* is keyed and its presumed taxonomic placement is noted among its Mexican and Central American relatives in Barkley et al. (in press).

The geographically restricted, subscapose *Senecio cuchumatanes* Williams & Molina (Phytologia 31:431. 1975) of Guatemala has a gross aspect similar to that of *Robinsonecio* and it may prove to belong there, but the taxonomic disposition of this distinctive species must await further information.

Robinsonecio T.M. Barkley & J.P. Janovec, gen. nov. TYPE SPECIES: *Robinsonecio gerberifolius* (Sch.Bip.) T.M. Barkley & J.P. Janovec.

Herbae perennes subscaposae e rhizomate radices fibrosas emittenti ortae. Folia majora in caespitem conferta, caulina bracteiforma. Capitula 1–7; phyllaria (plus/minus) aut 13 aut 16–20, inter se aequilonga sed in series exteriorum at interiorum ordinata; flosculorum microstructura cum tribu *Senecioneis* subtribu *Tussilagininis* conformis, superficeibus stigmatibus trans styli ramulorum faciem interiorum continuis staminumque filamentis cylindricis. $n = 30$.

Subscapose herbs 10–30(+) cm tall, herbage variously tomentose to arachnoid or lanate, unevenly glabrate in age. Stems single or rarely 2, arising from a thick, fibrous-rooted rhizome. Basal leaves in a prominent rosette, blades ovate to lanceolate or spatulate and tapering to a weakly winged petiole, margin revolute or flat and with callose denticles; cauline leaves few and reduced. Capitula 1–7(+); principal phyllaries ca. 13 or ca. 16–20, about equal in length but in an inner and an outer series; ray florets ca. 12–13(+), pistillate, and apparently fertile; disk florets bisexual and fertile; stigmatic surfaces continuous across the inner faces of the style branches; upper stamen filaments cylindrical and without expanded collars. Achenes glabrous or with appressed hyaline hairs; pappus of both ray and disk florets of abundant, white, minutely barbellate bristles that are about as long as the disk corollas. $n = 30$.

The genus name is derived from Robinson and *Senecio* to honor Dr. Harold Robinson, an intrepid explorer of the highways and byways of systematic botany.

KEY TO SPECIES

1. Capitula (1–)3–7(+); principal phyllaries greenish or yellowish to lightly anthocyanic; calyculate bracts linear and nearly as long as the principal phyllaries; achenes glabrous. 1. **Robinsonecio gerberifolius**
 1. Capitula 1(–2); principal phyllaries with margins and apex pinkish-purple to magenta; calyculate bracts few and reduced; achenes apparently with appressed, hyaline hairs. 2. **Robinsonecio porphyresthes**
1. **Robinsonecio gerberifolius** (Sch.Bip. in Hemsley) T.M. Barkley & J.P. Janovec, comb. nov. BASIONYM: *Senecio gerberifolius* Sch.Bip. in Hemsley, Biol.

Centr. Amer. Bot. 2:240. 1881. TYPE: MEXICO. VERACRUZ: pic d'Orizaba, 1838, *J. Linden* 487 (ISOTYPES: GH!, K, KSC-photo of K!, MICH!).

Subscapose perennial herb 1.5–2.5(–3+) dm tall; herbage densely to loosely floccose-tomentose to arachnoid or lanate, unevenly glabrate in age, especially on the upper sides of the leaves. Stems 1(–2), arising from a thick, fibrous-rooted creeping rootstock. Basal leaves in a prominent rosette, blades ovate to ovate-lanceolate or spatulate, tapering to a weakly winged petiole, 4–18 cm long overall and 1–3(–4) cm wide, coriaceous, margin minutely toothed, weakly revolute; cauline leaves few, reduced to mere bracts. Capitulescence a corymbiform cyme of 3–7(+) heads; principal phyllaries ca. 13, broadly ovate and of equal length, in an inner and an outer series, (8–)10–15 mm long, the tips greenish or yellowish to but lightly anthocyanic; calyculate bracts linear, 4–7 and nearly as long as the phyllaries; ray florets ca. (8?–)13, the ligule 12–16 mm long. Achenes glabrous, 3.5–4 mm long. $n = 30$.

Alpine and subalpine grasslands and open woodlands at high elevations in selected sites in the Trans Mexican Volcanic Region of Mexico and in the Sierra de los Cuchumatanes in Guatemala.

Specimens examined: **MEXICO**. DISTRITO FEDERAL: Telapón, Sep 1937, *E. Lyonnet* 1653 (NY). MEXICO (Edo.): Ixtaccihuatl, 30 Jul 1958, *J.H. Beaman* 1948 (GH, MEX, MO, NY, WIS, UC); Tlaloc, 22 Aug 1958, *J.H. Beaman* 2303 (GH); Telapón, 20 Nov 1965, *W. Boege* 23 (CAS); Contrafuertes de la Joya, 13 Aug 1955, *R.T. Clausen* s.n. (NY); cerca Paso de Cortes, 10 Sep 1966 *R. Cruz Cisneros* 1170 (WIS); Ixtaccihuatl, 23 Oct 1976, *J. Garcia P.* 171 (CAS, F, MICH, NY); Ixtaccihuatl, 27 Jul 1984, *J. Garcia P. & M. Bonzales* L. 1810 (CAS, KSC); Ixtaccihuatl, 16 Aug 1960, *H. Iltis, F. Iltis, & R. Koeppe*n 989 (MICH, WIS); Telapón, Dec 1928, *E. Lyonnet* 395 (GH, MO, NY); Ixtaccihuatl, 13 Sep 1953, *E. Matuda* 29036 (NY); La Joya de Alcalican, 14 Nov 1976, *R.A. Morales* A. 164 (WIS); Ixtaccihuatl, Oct 1905, *C.A. Purpus* 1516 (F, GH, MO, NY); Ixtaccihuatl, 30 Dec 1965, *J. Rzedowski* 22773 (MICH); Ixtaccihuatl, Dec 1968, *R. Weber*, s.n. (CAS). **PUEBLA**: Ixtaccihuatl, 12 Sep 1958, *J.H. Beaman* 2535 (MICH). **VERACRUZ**: Orizaba, 16 Aug 1958, *J.H. Beaman* 2290 (GH); Cofre de Perote, 27 Sep 1973, *C. Delgadillo & J. Dorantes* 3085 (F); Cofre de Perote, 27 Jun 1982, *G. Diggs, M. Nee, & G. Schatz* 2594 (F); Cofre de Perote, 28 Aug 1971, *J. Dorantes* 324 (GH, MO); Cofre de Perote, 20 Aug 1972, *J. Dorantes et al.* 01560 (MO); Cofre de Perote, 2 Oct 1984, *J. Garcia et al.* 1901 (CAS, KSC); peak of Orizaba, Aug 1840, *H. Galeotti* 2170 (K, photo-KSC!, paratype); Pic Orizaba, 1867, *Liebman* 140 (K, photo-KSC!, paratype); Citlaltepétl (Pico de Orizaba), 30 Jun 1949, *L.W. Swan*, s.n. (CAS). **GUATEMALA**. HUEHUETANANGO: cumbre de la Sierra de los Cuchumatanes, 28 Dec 1940, *P.C. Standley* 81489 (F); between Tojquiá and Caxín, Sierra de los Cuchumatanes, 6 Aug 1942, *J.A. Steyermark* 50178 (F, MO).

2. **Robinsonecio porphyresthes** (T.M. Barkley) T.M. Barkley & J.P. Janovec, comb. nov. BASIONYM: *Senecio porphyresthes* T.M. Barkley, *Phytologia* 67:243. 1989. TYPE: MEXICO. TAMAULIPAS: on mountain top 7 km SW of Miquihuana in forest of large pines, forest floor of low vegetation, elev 3430 m (23°40'N 99°45'W), 5 Aug 1941, *L.R. Stanford, L. Rutherford, & R.D. Northcraft* 679 (HOLOTYPE: NY!; ISOTYPES: GH!, MEXU!, MO!, NY!, WIS!).

Subscapose herb 1.0–1.5 dm tall, herbage closely lanate- tomentose, but loosely tomentose toward the base with long, arachnoid hairs, unevenly glabrate in age, upper side of leaves glabrescent, lower side persistently felted-lanate. Stem 1, arising in a cluster of basal leaves at the end of a rhizome. Rhizome creeping, simple, nearly 1 cm in diameter, covered by exfoliating bases of old leaves and producing abundant fibrous branching roots. Basal leaves with blades narrowly oblanceolate to subspatulate, tapering to a winged petiole, 4–10(–12) cm long overall and (0.8–)1–1.5 cm wide, subcoriaceous, margin denticulate with callose denticles, weakly revolute or flat; cauline leaves 2–5, reduced to mere linear bracts to 15 mm long. Capitula 1(–2), principal phyllaries ca. 16–20, linear-lanceolate and of equal length, in an inner and an outer series, 12–14 mm long, the margins and tip permanently and prominently pinkish-purple or magenta; calyculate bracts few and reduced; ray florets 12(+?), the ligule 10+ mm long. Achenes with flat, hyaline hairs that presumably persist, 2 mm long (immature).

A distinctive entity known to us only from the type collection, cited above. If it has been collected again in the intervening years, the specimens have escaped our attention.

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It is a pleasure to thank the curators of the above noted herbaria for lending specimens. Jose Luis Villaseñor of the Herbario Nacional (MEXU), Instituto de Biología, Universidad Nacional Autónoma de México, gladly shared his superb knowledge of the Mexican Compositae with us. Rupert Barneby of the New York Botanical Garden kindly prepared the Latin diagnosis. Relevant type specimens were located by D.J.N. Hind in the herbarium of the Royal Botanic Gardens, Kew (K), and photocopies were graciously supplied. This paper is Contribution No. 96-397-J from the Kansas Agricultural Experiment Station, Manhattan.

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BOOK NOTICE

BRAKO, LOIS, AMY Y. ROSSMAN, and DAVID F. FARR. 1995. **Scientific and Common names of 7,000 Vascular Plants in the United States.** (Contr.U.S. Nat. Fungus Coll. No. 7). (ISBN 0-89054-171-X, pbk.) American Phytopathological Society Press, 3340 Pilot Knob Road, St. Paul, Minnesota, 55121, 612/454-7250. \$29.00. 304 pp.

Designed primarily with the plant pathologists and agriculturists in mind, this book is a useful resource for anyone interested in the common names for plants native to and cultivated in the United States, including Hawaii and southern California, Texas, and Florida. The book is well designed to facilitate its use with four cross-referenced alphabetical sections: 1) Scientific names - entry by genus followed by the family name and generic common name, if any; species listed under each genus followed by one or more vernacular names; authorities given for all listed taxa. 2) Common names - multiword names entered separately under each word of the name; the complete name(s) listed under the indexed word; and the Latin name placed after the vernacular. 3) Synonyms - scientific names by which a species may be known are listed, followed by the correct latin name; appears to be somewhat incomplete. 4) Families and Genera - the included genera listed by family.

The included taxa were selected from standard phytopathological, floristic, and agronomic references. Only those taxa are given for which common names are published in the consulted sources. No attempt has been made to manufacture "standard" common names for other species of a genus. Hence, the coverage of genera is rather exhaustive (e.g. Bombacaceae with five listed genera, Bignoniaceae with 12, and Myrtaceae with 16), whereas the coverage of (non-agricultural) species is much less complete (e.g. only 14 listed species of *Verbena* [including *Glandularia*], only six species of *Tradescantia s.l.*, and six of *Penstemon*; however, 25 species of *Trifolium*).—Roger Sanders, Research Associate, Botanical Research Institute of Texas.

A NEW VARIETY OF *SWERTIA* *RADIATA* (GENTIANACEAE)

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ABSTRACT

Plants of the wide-ranging *Swertia radiata* from the Sierra de la Madera near Cuatro Ciénegas, Coahuila, in México differ from all other populations in having corollas that only partially open and remain globose at anthesis. As this feature is consistent throughout the Sierra de la Madera, the plants are recognized as a new variety, *S. radiata* var. *maderensis*.

RESUMEN

Las plantas de *Swertia radiata*, una especie de distribución amplia, procedentes de la Sierra de la Madera, cerca de Cuatro Ciénegas (Coahuila, México), se diferencian del resto de las poblaciones por tener corolas que se abren solo parcialmente y permanecen globosas durante la antesis. Dado que este carácter es consistente a lo largo de toda la Sierra de La Madera, estas plantas son reconocidas aquí como una nueva variedad: *S. radiata* var. *maderensis*.

Studies in connection with the Chihuahuan Desert Flora project have provided specimens of *Swertia radiata* (Kellogg) Kuntze from the Sierra de la Madera near Cuatro Ciénegas in central Coahuila, México. These specimens differ from all other collections of this wide-ranging species in that their petals remain erect at anthesis forming a globose corolla. In all other populations of the species the petals are distinctly spreading at anthesis. Based on this character, which is consistent throughout the Sierra de la Madera, the plants are recognized as a new variety.

***Swertia radiata* var. *maderensis* Henrickson var. nov. (Fig. 1)**

Differt a var. *radiata* petalis erectis corollam cupulatam facienti (petalis non reflexis), staminibus erectis per anthesin non patulis.

Perennial, rarely biennial, monocarpic? herbs 3–18 dm tall from a thickened, black-barked taproot; stems 0.7–1.5 cm wide at the base, glaucous, glabrous. Basal rosulate leaves lanceolate, oblong-lanceolate to oblong-oblan-ceolate, (10–)15–30 cm long, 2–4 cm wide, tapering to a winged petiole at base, present as rosettes throughout the growing season; cauline leaves whorled, (2–)3–4(–6) per node, of similar outline to the basal leaves, 5–15 cm long, (1–)2–3 cm wide, reduced to leafy bracts in the inflorescences, all

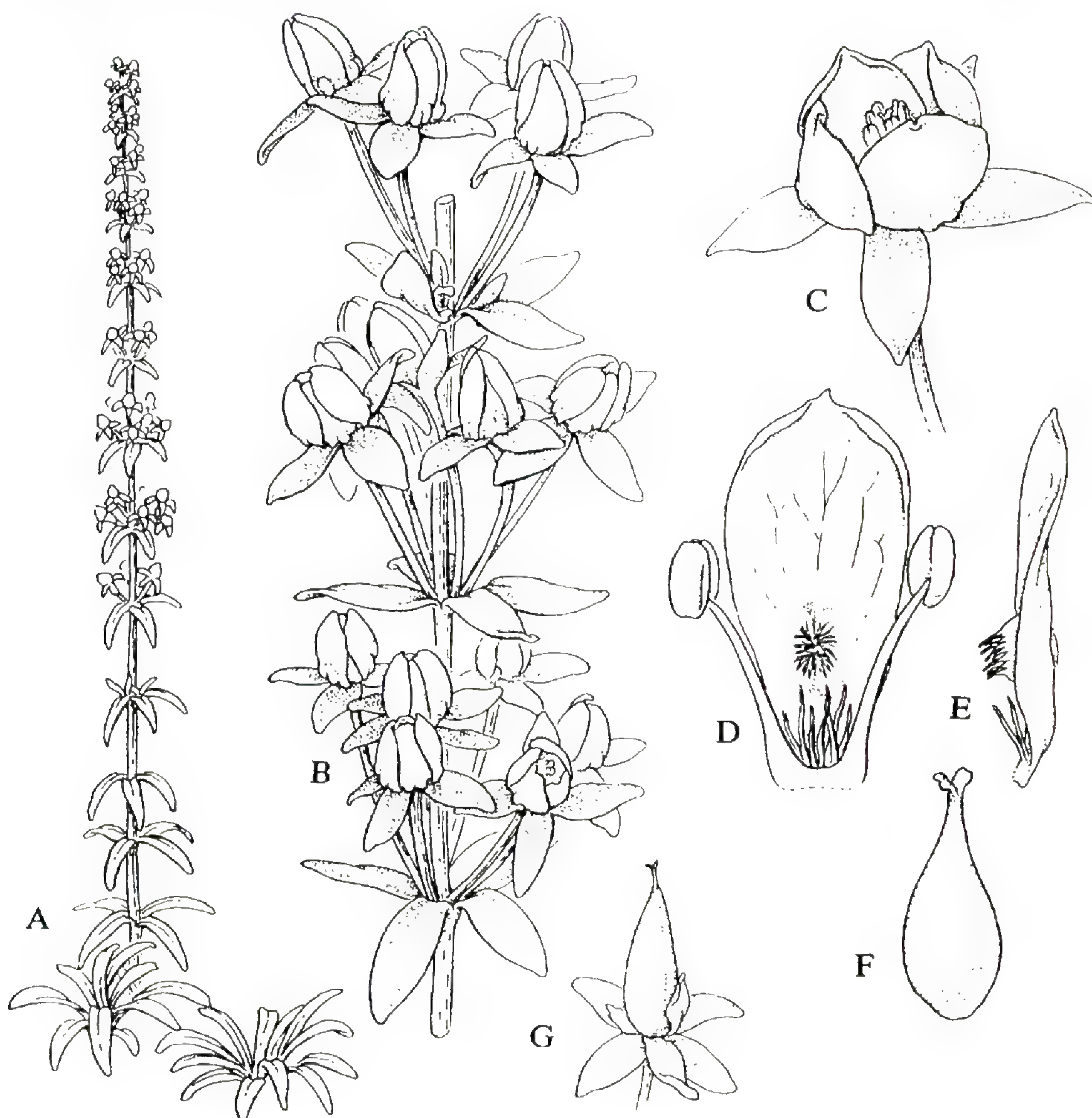


FIG. 1. *Swertia radiata* var. *maderensis*. A. Growth habit showing basal rosettes and an erect flowering plant, which develops directly from the central rosette. B. Portion of flowering stem showing subtending whorled leaves, flower distribution, spreading sepals and globose corolla. C. Flower with characteristic globose corolla; note outer impression of the paired basal petal foveae. D. Petal abaxial view showing basal fringed corona, the paired foveae with the marginal fringes. E. Same in side view. F. ovary. G. Immature fruit. All from *Henrickson & Wendt 11887*.

leaves acute to $\pm$ obtuse at tip, broadly to narrowly cuneate at the sessile, sheathing base, entire, fleshy, glaucous, glabrous. Flowers borne in much-branched dichasia, or cymose, leafy-bracted panicles (4–)5–9 cm long, these often continuous from the lower half or base of the plant to the tip; pedicels 25–65 mm long; sepals 4, lanceolate, lance-ovate, 9–15 mm long, green with white, entire to finely erose margins, spreading at anthesis; corolla tubes 1–2 mm long, the corolla lobes obovate to oblong-ovate, 9–18 mm long, 6–13 mm wide, obtuse to apiculate at the tips, the margins incurved

distally, pale dull green, more yellowish upon drying, spotted with purple inside, incurved and erect at anthesis forming a cup-like corolla, each corolla lobe with a pair of parallel foveae (glands) on lower inside surface, the glands 2.5–4.5 mm long, 0.8–1.7 mm wide, surrounded by a strongly fringed membrane 2–4 mm high, the corolla-tube base with a fringe of united fimbriae 2.5–8 mm long forming a corona; stamens erect at anthesis, filaments 5–10 mm long; anthers 2.5–4 mm long, inverted (the anther tip pointing downward), slightly purplish to light yellow-white, visible at the opening of the corolla; ovary 8–10 mm long; style 2–4 mm long. Fruit 2–3 cm long, 5–7 mm wide, the style persistent; seeds 2.5–4 mm long, 2–3 mm wide, pitted, rusty-brown, winged along the angles.

TYPE: MEXICO: COAHUILA. ca. 40 km WNW of Cuatro Ciénegas in limestone Sierra de la Madera, in mid canyon just west of Cañón de la Hacienda, near 27°02'N, 102°51'W, 7800 ft, 28 Sep 1980, *Henrickson 18659* (HOLOTYPE: TEX!; ISOTYPES: ARIZ, TEX, MEXU).

Additional collections: MEXICO. COAHUILA: Sierra de la Madera, high crest of main ridge about 2 km E of Picacho de Zozaya, 8600–8800 ft, 13 Sep 1941, *I.M. Johnston 9035* (LL); ca. 35 air mi S of Cuatro Ciénegas in Cañón de la Hacienda on limestone, Sierra de la Madera, 27°03'N, 102°24'W, 7300–9000 ft, 5 Aug 1973, *Henrickson & Wendt 11887* (TEX).

The Sierra de la Madera is an isolated east-west oriented limestone range near the eastern edge of the Chihuahuan Desert in central Coahuila that rises to 3032 m elevation. The Sierra's massiveness and orientation relative to prevailing air movements from the Gulf of Mexico result in development of heavy cloud covers during much of the summer rainy season. The upland forests contain stands of *Pinus strobiformis* Engelm., *Abies durangensis* Martínez var. *coahuilensis* (I.M. Johnst.) Martínez, *Pseudotsuga menziesii* (Mirb.) Franco var. *glauca* (Beissn.) Franco, and *Cupressus arizonica* Greene along with species of *Quercus*, *Arbutus*, *Arctostaphylos*, and *Garrya*, and in the mossy understory the new taxon is very common. When first observed in flower (*Henrickson & Wendt 11887*), the plants were distinctive in their globose, dull greenish corollas. Subsequent observations of the species in California, Nuevo León, Arizona, and in various wildflower books, as well as in herbaria (ARIZ, RSA-POM, TEX, LL) have shown that in this feature, the population from the Sierra de la Madera is unique.

Swertia radiata is a wide-ranging species with collections known from southern Washington, southwestern Montana, Idaho, Wyoming, the Black Hills of South Dakota, eastern California, Nevada, Utah, Colorado, Arizona, New Mexico, west Texas (Guadalupe Mountains) and the high mountains of central Nuevo León, México (Sierra Coahuilon, Sierra la Marta, Cerro Peña Nevada, Cerro del Potosí) and in central Coahuila (Sierra de la Madera).

In the material I have seen of populations outside of Coahuila, the petals are dull light green to light yellowish, typically maculate with purple,

sometimes with a larger purple spot near the petal gland or near the tip; but in all cases the cupped corolla lobes and stamens are strongly spreading at anthesis. In contrast the corollas from the Sierra de la Madera populations remain erect forming a distinct globose cup, and the petals are dull light green or yellow-green with sparse purplish maculations and with a purple marking at the very base below the glands. The anthers are also slightly purplish in color, though they dry a light yellow color.

There is disagreement as to the generic placement of the species. It has been included in *Swertia* as *Swertia radiata* (Kellogg) Kuntze [Higgins (1987), Pringle (1993)] and in *Frasera* as *Frasera speciosa* Dougl. ex Griseb. in Hook. [Hitchcock (1959), Munz (1959), Holmgren (1984)]. Holmgren (1984) neatly distinguished the two genera—*Swertia* having 5-merous flowers with short, thick styles, alternate to subopposite leaves, occurring in wet-moist habitats, and an Old World distribution, with our one New World species *Swertia perennis* L. being circumboreal. In contrast his *Frasera* has 4-merous flowers with slender styles, opposite or whorled leaves, and occurs in drier habitats in the New World. Pringle (1979, 1990), however, has concluded that recognition of two genera is not warranted when considering the wide range of variation present in Old World *Swertia*. He notes that some species of *Swertia* have distinct styles [see also St. John (1941)], and others have 4-merous flowers and that the generic distinctions are not clearly supported by the various cytological, palynological, or phytochemical studies undertaken [see references in Pringle (1979, 1990)]. Thus the species is recognized as *Swertia* in this study.

Throughout the range of the species many variants have been named, all associated with differences in plant size and vestiture. *Frasera speciosa* var. *scabra* M.E. Jones (1893), of central Arizona, was based on strongly scabrous plants with small leaves and large flowers. Three new taxa were proposed by Greene (1900): (1) *Frasera venosa* Greene of southwest New Mexico, with narrow, strongly veined leaves; (2) *Frasera ampla* Greene of northern Arizona with minutely hirtellous-scabrellous herbage, large but not notably veined basal leaves, and shorter sepals; and (3) *Frasera macrophylla* Greene of southern Colorado, robust plants with large, glabrous leaves, long sepals, and purple-tipped corolla lobes [this taxon was retained as a glabrous variety by St. John (1941)]. Lastly, P.A. Rydberg recognized two varieties of *Frasera speciosa*: (1) var. *stenosepala* Rydb. with numerous flowers, narrow, long sepals, long petals in Colorado and Wyoming, and (2) var. *angustifolia* Rydb., low plants with short basal leaves, short, narrow cauline leaves, and small flowers from Montana to Colorado. None of these taxa, based on growth form and vestiture differences, have been recognized in modern floras except for taxon *macrophylla* as noted above. It is certainly realized that the taxon proposed in this paper is of a minor nature, but the charac-

ters upon which it is based are consistent throughout the large population in the Sierra de la Madera and in this feature it stands apart from other populations of the species. One could suspect that its differences may be associated with a change in pollinator.

The flora of the Sierra de la Madera and adjacent Cuatro Ciénegas basin has been enumerated by Pinkava (1984). The new variety joins a long list of taxa endemic to the Sierra de la Madera including *Clematis coahuilensis* Keil, *Rosa woodsii* var. *maderensis* Henrickson, *Sedum parvum* subsp. *diminutum* Clausen, *Euphorbia pinkavana* M. C. Johnston, *Choisya katherinae* C. H. Muller, *Poliomintha maderensis* Henrickson, *Satureja maderensis* Henrickson, *Penstemon henricksonii* Straw, *Agave scabra* subsp. *maderensis* Gentry, and *Festuca coahuilana* González & Koch.

ACKNOWLEDGMENTS

I thank Tom Wendt (LSU) and the reviewers for comments on the manuscript, Paul Fryxell (TEX) for the Latin translation, F. Javier Fuertes-Aguilar (TEX) for translation of the abstract, Bobbi Angel (NY) for the illustration, and the Plant Resources Center at the University of Texas, Austin, for use of facilities.

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BOOK NOTICES

BREEDEN, JAMES O. (ed. & intro.) 1994. **A Long Ride in Texas: The Explorations of John Leonard Riddell.** (ISBN 0-89096-582-X, hbk.) Texas A & M University Press, Drawer C, College Station, TX 77843-4354, (409) 845-1436. \$24.50. *frontisp.* + xviii + 144 pp., 3 figs, 1 map.

Recently discovered in the archives of Tulane University, the travel diary of J.L. Riddell's explorations of central Texas forms the core (62pp.) of Breeden's presentation of Riddell's contribution to Texas natural history. Although Riddell attempted several times to publish his journal, he failed to find an interested publisher and set it aside. Years after his death, a daughter-in-law donated it to Tulane University, where he had been a professor for 29 years. The journal is of considerable interest because it documents his observations of the geology, botany, and zoology of the Texas Hill Country in 1839. This antedates by almost 10 years the exploration of Ferdinand Roemer, who is generally thought to be the first natural historian to the region.

To round out Riddell's contribution to Texas, Breeden includes an extensive preface (8pp.), a brief but insightful biography of Riddell (34pp.), and an unaltered version (9pp.) of Riddell's major published article on Texas ("Observations on the Geology of the Trinity Country, Texas, made during an excursion there in April and May, 1839." *Amer. J. Sci. Arts.* 37:211–17. 1839.). In the case of the preface, biography, and diary, Breeden provides copious end notes to explain outdated plant names, geographic locations, customs, and obscure references made by Riddell. These notes add a dimension to the readability of this volume. —*Roger Sanders, Research Associate, Botanical Research Institute of Texas.*

LAWERENCE, ELEANOR. 1995. **Henderson's Dictionary of Biological Terms: Eleventh Edition.** (ISBN 0-470-23507-1, hbk.) John Wiley & Sons, New York, New York. (1-800-225-5945) \$39.95. 693 pp.

The updated version of this standard reference dictionary incorporates terms related to recent advances in molecular biology and genetics. The main dictionary portion now includes about 23,000 entries. It will serve botanists primarily as an information source for disciplines with which they are least familiar; classical botanical terms are often omitted (e.g. salverform, hypocrateriform, nexine, tricolpate, fractiflex, medifixed, prolepsis, and brochidodromous lacking; cataphyll inadequately defined). Other helpful provisions and appendices include: abbreviations, units/conversions, decimal prefixes, the Greek alphabet, common Latin and Greek plural endings, structures of 80 common biochemicals, classification outlines of organisms and viruses (modern evolutionary, non-cladistic schemes), and Greek and Latin word roots. The promotional literature purports "Figures that help clarify complicated terms." In reality this amounts to 12 rather crude diagrams of such items as parts of the flower, trophic level pyramid, and meiosis.—*Roger Sanders, Research Associate, Botanical Research Institute of Texas.*

NOTES ON *SPIGELIA* (LOGANIACEAE)

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ABSTRACT

A treatment is provided for the species of *Spigelia* formerly in the genus *Coelostylis* that lack elongated secund inflorescences. Two taxa are recognized: *Spigelia loganioides* (including *S. texana*), and *S. bedyotidea* (including *S. lindheimeri*, and *S. coulteriana*).

RESUMEN

Se presenta un tratamiento taxonómico para las especies de *Spigelia* anteriormente incluidas en el género *Coelostylis*, o sea las especies sin inflorescencias elongadas y unilaterales. Se reconocen dos taxa: *Spigelia loganioides* (incluyendo *S. texana*), y *S. bedyotidea* (que incluye *S. lindheimeri* y *S. coulteriana*).

INTRODUCTION

This paper deals with the species of *Spigelia* placed by Torrey and Gray in their genus *Coelostylis*, namely *Spigelia loganioides* (Torr. & A.Gray in Endl.) A.DC., of Florida, *Spigelia texana* (Torr. & A.Gray) A.DC., of Texas and *Spigelia lindheimeri* A.Gray of Texas and north central Mexico.

North American *Spigelia* were previously studied by Homer Hurley (1968), but his taxonomic conclusions were never published. This treatment differs from that of Hurley. He intended to accept *S. lindheimeri* as a variety of *S. texana*, and he considered *S. loganioides* synonymous with *S. texana*. However, *S. loganioides* is an older name than *S. texana*, and also *S. lindheimeri* differs from *S. loganioides* and *S. texana* in several characteristics including growth habit, leaf size, leaf placement, vestiture, and corolla throat width that support its recognition at the species level. Studies of the type *S. bedyotidea* show it is referable to *S. lindheimeri*, and *S. bedyotidea* is older than *S. lindheimeri*; studies of the type of *S. coulteriana*, reveal that it has been misapplied and belongs within the *Coelostylis* group.

TAXONOMY

Spigelia loganioides, *S. texana* and *S. lindheimeri* have been considered by Torrey and Gray (1839, 1841) and Small (1903) to constitute the genus *Coelostylis*. *Coelostylis* was merged into *Spigelia* by A. deCandole (1845) and later accepted as such by Gray (1878). Torrey and Gray's *Coelostylis* differs from the other species of *Spigelia* primarily in the basic structure of the

inflorescence (Fig. 1). Both groups have terminal, highly modified, determinate, dichasial inflorescences and the plants often exhibit a dichotomous branching pattern effected by the presence of terminal inflorescences. In the *Coelostylis* group the upper nodes produce two flowers, a terminal flower on a short, ebracteolate pedicel that is the first to open, and a second flower that develops laterally, opposite a stipule, produced upon a 3-bracted peduncle-pedicel that is longer than pedicel of the first flower (Fig. 1b–d). Each node also produces two shoots from the leaf axils that terminate in a node with two leaves, 2 flowers, and two more lateral shoots in a dichotomous branching pattern that is again repeated. Some plants produce only a single lateral shoot at the upper nodes and exhibit unilateral branching producing leafy monochasia. This pattern is consistent in *Coelostylis* with one exception, a specimen of *S. loganioides* that produced two flowers on the longer stalk, each separated by a three bractlets (Ginzburg & Davis 914, TEX). But the specimen still produced the single terminal, ebracteate flower characteristic of the group.

In the true *Spigelia*s, the inflorescences are again terminal and structurally determinate, and bordered by lateral leaves that may produce lateral branches, but they appear as indeterminate, elongated, one-sided spikes or racemes. However, structurally they are determinate, laterally branched, helicoid cymes derived from a dichasia through strong one-sided lateral branching (Fig. 1e–g). The flowers may be sessile or slightly pedicellate along the inflorescence axis, and each flower is subtended by two bracts, one lateral to the flower, the other either above or below the flower on the inflorescence axis (Fig. 1e), and the bracts occur on alternate sides in consecutive flowers, which indicates that the inflorescence may actually be a scorpioid cyme.

The inflorescences alone has served to separate the two groups at the generic level, however, some species of *Spigelia* produce flowers that are essentially identical to those of *Coelostylis* and the two groups have been combined within *Spigelia*. *Coelostylis* is not formally recognized as a genus or section or subgenus of *Spigelia* in this paper, as I defer classification to Katherine Gould, who is presently studying the genus at the University of Texas, Austin.

While *Coelostylis* is no longer recognized as a genus, the comprising taxa form a closely related group that share many characteristics. They are perennial herbs with few to several stems arising from underground fibrous root-bearing rootstocks. The roots often have a pink color, and the plants are thus known as pink-root or worm-grass (Godfrey & Wooten 1981). The stems are erect to ascending, sometimes basally decumbent, few to several branched from the base. Flowering stimulates lateral branching often in a dichotomous pattern, but one or three lateral shoots are produced

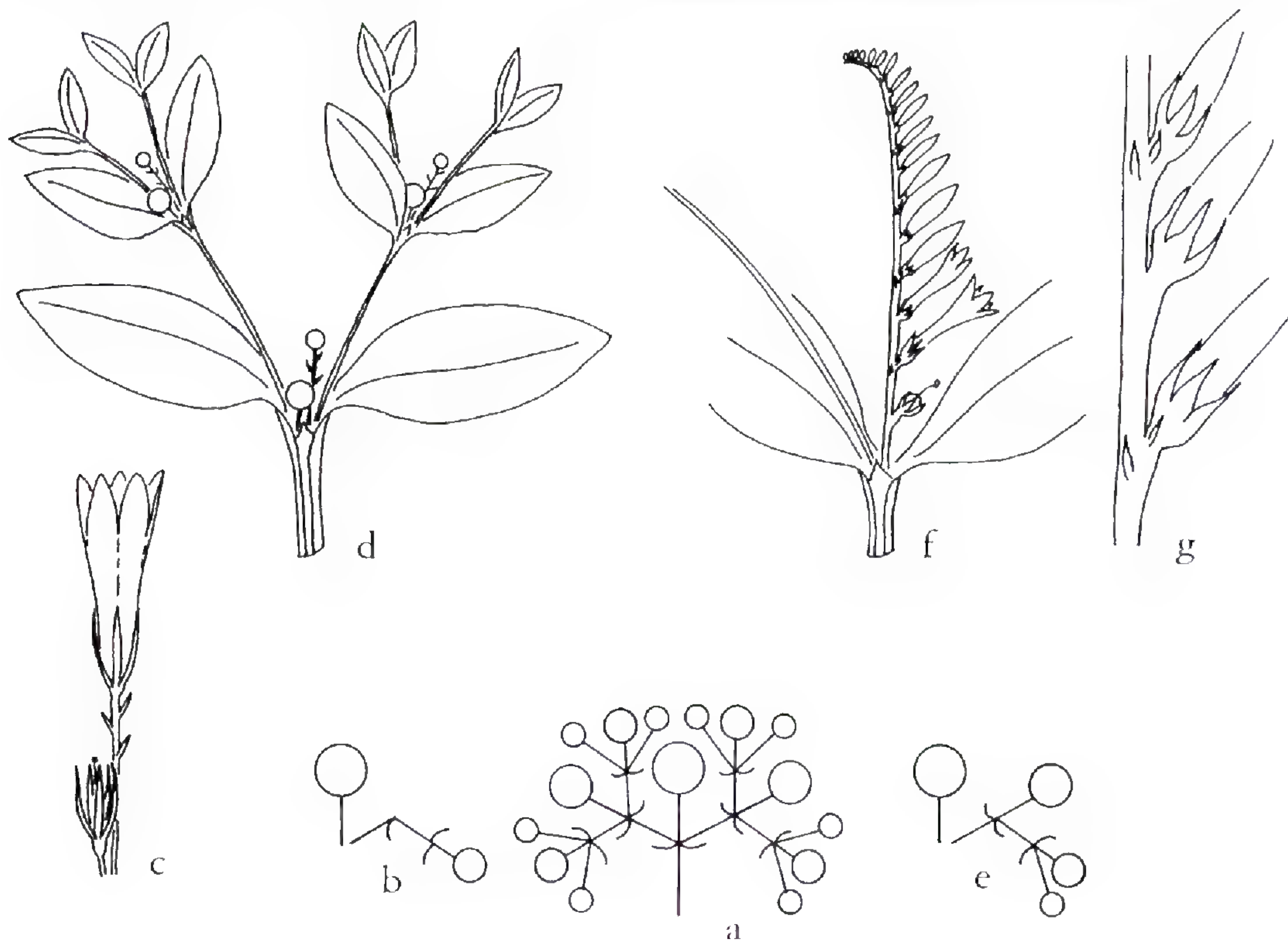


FIG. 1. Comparative diagrams and drawings of the *Coelostylis* and *Spigelia* inflorescences. A. Diagram of dichasium; a determinate inflorescence with opposite lateral branching. B. Diagram of flower clusters in *Coelostylis* group as modified from the basic dichasium structure; retaining one terminal flower on an ebracteolate pedicel, and a lateral flower on a peduncle-pedicel subtended by three bracts. C. Drawing of nodal flower cluster in *Coelostylis*. D. Drawing of inflorescence of *Coelostylis*; each node has one terminal flower, one lateral flower produced opposite a stipule (flowers shown as circles), two shoots produced from the leaf axils that repeat the pattern. E. Diagram of possible origin of inflorescence of *Spigelia* group as modified from the basic dichasial structure. F. Terminal helical cymose inflorescence of *Spigelia humboldtiana* showing one-sided orientation of flowers, continued branching occurs through axial shoots. G. Enlargement of f, showing the presence of two bracts at nodes of inflorescence. The bracts occur on alternate sides of consecutive flowers.

at the flowering nodes. The internodes are shortest near the base, longest medially. The nodes each have two leaves, the margins of which extend as decurrent wings down the subtending internodes, and two, broadly deltate, acute to rounded, whitish, membranous, erect stipules lie between the paired leaf bases. The stems may be glabrous, or more commonly, they have distinct papillae at the nodes, on the stipules, and on the margins of the decurrent wings.

Leaves are opposite, but in *S. loganioides* are often produced in a conspicuous whorl of four large leaves below the inflorescence caused by the suppression of an internode. In most plants the lower-stem leaves are more oblong-ovate, oblong-elliptical, sometimes ovate to obovate, more obtuse

to rounded at the tip, and subpetiolate to petiolate. The upper-stem leaves may be similar to the lower leaves in shape or they may be considerably larger, more lanceolate, elliptic to narrowly ovate, acute, sessile, and thinner in texture. The blades are bicolored and range from thin and membranous, to firm and sub-coriaceous; the midvein is impressed above, and the midvein and secondary arcuate veins are raised and sometimes yellowish beneath. The leaf surfaces may be smooth or scabrous with hardened papillae, particularly along the basal margins of the upper surface.

Flowers, as noted above, are terminal at the nodes, with each node producing 2 leaves and 2 flowers, one terminal with an ebracteolate pedicel 0.5–3 mm long, the second produced opposite a stipule with a longer peduncular-pedicellar stalk 5–10(–14) mm long that bears 2–3 subulate bracteoles 1–3(–6.5) mm long. In addition each upper node produces 2 (sometimes 1 or 3) leafy shoots, from the leaf axils, and these shoots again terminate in leaves and flowers.

Calyces are deeply 5 parted, with linear to narrowly lanceolate, acute to obtuse, green, scarious-margined, sometimes papillate-margined sepals. The corollas are salverform to funnelform, thickish, white or tinged or vertically striped with pink or lavender, 10–20 mm long. The tubes are angled to cylindrical, slightly ampliate. The 5 lobes are oblong-ovate, obtuse, valvate, and their margins flare outwards in bud. The stamens are epipetalous, borne in the mid or distal corolla tubes, with free filaments only 1–1.5 mm long; the linear, sagittate, introrse anthers surround the style. The styles are included to slightly exserted, cylindrical and is densely pilose-setose medially—the hairs serve to remove the conspicuous yellow pollen from the anthers as the style elongates. The stigmas are capitate, slightly 2-lipped, and the terminal 70 percent of the style is deciduous leaving a hardened style base tipped with a crown-like structure on the fruit.

Fruit consist of 2 (rarely 3) indurate, sclerified, obovoid to nearly spheroid, yellowish cocci fused for 70–80 percent of their common surface. The outer surface may be initially papillate, but later is smooth and marked with stronger yellow veins. The fruit cocci dehisce along the common vertical septum with the two halves springing opening and falling from the subtending nectary disk. The basal disk is spongy but strongly indurated, plate-like, stramineous, oblong-elliptical in outline and obtuse at each end as seen from above. Each cocci contains 6, (rarely 10–12) seeds that develop around a central placenta. The seeds are obpyramidal, with the outer surface uneven, spongy-pitted; the interior 3 surfaces are more coarsely tuberculate-ridged. The inner-most point has a prominent hollow pit marking the point of vascular attachment.

The *Coelostylis* and *Spigelia* taxa and the two taxa comprising taxa *Coelostylis* can be distinguished by the following key:

- A. Flowers 2 per node, the first-to-flower terminal with an ebracteolate pedicel 1–3 mm long, the lateral flower with a three-bracteate peduncle-pedicel 5–14 mm long; the flowering nodes producing (1–)2(–3) lateral leafy shoots that repeat the pattern. **The *Coelostylis* group**
- B. Plants 1.5–3.5 dm tall with 1-few stems from the base, the mid-stem leaves mostly oblong-lanceolate, 3–6 cm long, (sometimes smaller and more ovate in Florida) drying thin membranous, the plants usually with a whorl of 4 leaves subtending the inflorescence; the internode wings papillate only for a short distance below the node; corollas broadly ampliate, 4–5 mm wide below the lobes; plants of west-central Florida and east-central Texas. ***Spigelia loganioides***
- B. Plants 0.5–1.2(–2) dm tall, usually bushy with many stems from the base; the mid-stem leaves mostly narrowly lanceolate (sometimes more ovate), 1.2–3(–3.5) cm long, typically rather thick with the upper surface variously papillate and wrinkled in dried specimens; the plants rarely forming a whorl of 4 leaves below the inflorescence; the internode papillate all along the internode wings and also on the internode between the wings; corollas narrowly ampliate, 2–3.5 mm wide below the lobes; plants of east-central Texas, north-central Mexico. ***Spigelia hedyotideia***
- A. Flowers produced in terminal, elongated, one-sided, spike-like or raceme-like inflorescences, the inflorescences actually of determinate helicoid cymes with indeterminate, unilateral branching. **The true *Spigelia*s**

***Spigelia loganioides* (Torr. & A.Gray in Endl.) A.DC., Prod. 9:4. 1845.**

Coelostylis loganioides Torr. & A.Gray in Endl. Nov. stirp. dec. (5):33, 1839; Iconogr. gen. pl. (9):t. 101, 1841 (illust.). TYPE: U.S.A. FLORIDA. Marion Co.: Prope Fort King, *Burrows & Alden s.n.* (HOLOTYPE: NY!, ISOTYPE: NY!).

Spigelia texana (Torr. & A.Gray) A.DC., Prod. 9:5. 1845. *Coelostylis texana* Torr. & Gray Fl. N. Amer. 2(1):44. 1841. TYPE: U.S.A. TEXAS: (exsiccata fascicle III) *Drummond 321* (HOLOTYPE: NY!, ISOTYPES: G!, GH!, GH!).

Erect, 1-few stemmed herbs (10–)20–30(–50) cm tall; internodes (1–)2–6(–8.5) cm long, glabrous except where papillate along the margins of the distal-most decurrent internode wings, on the stipules, and on the lower leaf margins. Leaves opposite, usually in a whorl of four below the inflorescences; basal-stem leaf blades often ovate, oblong-ovate, to 2 cm long, acute to rounded at the tip, tapered to a winged petiole at the base, the mid- and upper-stem leaf blades narrowly ovate, lanceolate, oblong-elliptical, elliptical to rhombic, (1.4–)3–6.5 cm long, (0.5–)1–1.7(–2.2) cm wide, acute, obtuse, mostly minutely apiculate at tip, the bases cuneate, sessile or tapering to a winged petiole-like base to 3 mm long, the margins entire, often revolute or enrolled when dry, fleshy, the blades drying thin membranous, glabrous except where sometimes scabrously papillate along the upper-surface margins above the petiole, glabrous, slightly more glaucous beneath. Terminal-flower pedicel 1–1.5(–2.5) mm long, ebracteolate; lateral-flower peduncle-pedicel 4–7(–14) mm long, with subulate bractlets 1–4.5 mm long, 0.2–0.4 mm wide; sepals linear-lanceolate, (2.5–)3.5–5.5

mm long (slightly accrescent in fruit), 0.4–1 mm wide at base, acute, glabrous or weakly scabrous along the margins; corollas white throughout or with vertical, pale-lavender lines extending up the tubes and bordering the lobes, funnelform, 12–14.5(–20.5) mm long, the tubes ampliate, 8–9(–15) mm long, to 4–5 mm wide at the throat (pressed), the lobes oblong-ovate, spreading, 3.5–5.5 mm long, 2.2–3.5 mm wide, acute, entire, thickish; stamens borne in the mid-corolla tubes; filaments 1–1.5 mm long; anthers 1.1–1.3 mm long; styles 6–7.5 mm long, included, the stigma borne in the distal tube, the persistent style base 1.7–2.3 mm long. Fruit cocci 2, nearly spheroidal, slightly divergent, glabrous, the pair 3–4.5 mm high, 5–5.5 mm wide, the subtending thickened disk (3.2–)4–5 mm long; seeds 6–12 per cocci, 1.5–1.8 mm long, 1.3–1.5 mm wide. (Figs. 2, 3a–c, 4).

As recognized here *Spigelia loganioides* occurs in both Florida and Texas. It is distinguished from *S. bedyotidea* by: (1) its taller growth habit; (2) its larger, usually more membranous leaves; (3) a tendency to be glabrous throughout except at the nodes where stiff papillae usually occur on the basal portion of the upper leaf margins and continue down the petiole and the distal portion of the decurrent internode wings, and on the margin and outer surface of the stipules; (4) its tendency to produce a whorl of four leaves below the leafy inflorescences, and; (5) the slightly longer, more conspicuously ampliate corollas. Specimens in Texas generally conform well to these features as do most specimens from Florida, however, some Floridian collections, including the type of *S. loganioides*, differ vegetatively.

While the type locality was designated in the original description as being near Tampa Bay, the type collection actually is from near Fort King in Marion County (Fort King now lies within the City of Ocala, Florida). Plants from this region differ from those of most other localities in having small, mostly broadly ovate, sometimes lanceolate, obtuse to acute-tipped, opposite leaves that do not form a whorl below the inflorescence; the plants are also relatively short in stature (Fig. 2a). The type collection, was made by Burrows and Alden near Fort King, (E. Silas Burrows was an army physician stationed for time at Fort King during the second Seminole War—1835–1842, Wunderlin pers. comm.) and the type specimen, illustrated in Endlicher (1841), is redrawn here as Fig. 2a. It consists of a curved stem 25 cm long, with ovate to broadly ovate, obtuse-tipped leaves 14–20 mm long and 6–8 mm wide in the distal 10 cm of the stem. The leaves are all opposite and do not form whorls below the flowers.

A second old collection from the type region, [in pinetis, prope Fort King, Florida, Jul 1848, *F. Rugel* 327, (GH-2 sheets, NY, FLAS)] also consists of moderately short plants 1–2 dm tall. Most (21) of the 24 stems present on these four sheets have ovate, sometimes broadly ovate, obtuse-tipped leaves similar to those present on the Burrows and Alden collection



FIG. 2. Variation in *Spigelia loganioides* in Florida. A–B. From the Fort King population in Marion Co., Florida, showing plants with more ovate, shorter leaves and both axillary and terminal flowers (Redrawn from the figure in Endlicher (1840) from the Burrows and Alden holotype). C. Typical specimen from Levy Co., Florida, showing obovate to ovate basal leaves and characteristic quartet of larger elliptical leaves and characteristic branching pattern. These plants are identical to plants from eastern Texas [From Wood, Wilson & Cooley 9169 (A)]. Magnifications as indicated.

with mid-stem leaves measuring 14–23 mm long, 9–11 mm wide. However, one GH and the NY sheet contain stems with larger, thinner, more elliptical, acute-tipped, mid-stem leaves, 22–25 mm long, 7–10 mm wide; these elliptical leaves are similar to those occurring in other specimens in western Florida. Other collections from the Ocala region (*Small, Mosier & DeWinkeler 10810*) and from Levy County (*Holland & Mears s.n.*, *Murriel s.n.*, *Garber s.n.*) are also small, to 2.5 dm tall, but have all opposite, more lanceolate to elliptical, acute leaves 2–3.5 cm. Still other collections (*Woods, Wilson & Cooley 9169*, *Curtis s.n.*) are taller, have ovate, obtuse- round-tipped leaves at the base, but more lanceolate leaves above and the leaves subtending the inflorescences may or may not form a single whorl of 4 leaves—this character varying from plant to plant. Through these and other specimens one sees that there is continuum from small plants with all ovate, obtuse-tipped, opposite leaves, to plants that have smaller, broadly ovate, obtuse-tipped leaves at the lower nodes, and larger more lanceolate, acute-tipped leaves at the mid and upper nodes that are all opposite in some specimens but form single whorls of leaves below the inflorescences in others. Still other plants have large lanceolate, elliptical-lanceolate leaves and well developed whorls of leaves below the inflorescences. All these plants have similar inflorescences and flowers.

The small, broadly ovate, obtuse-tipped leaves characteristic of the type collection (Fig. 2a) initially stand in strong contrast to the larger, elliptic, acute-tipped leaves found on other spigelias in Florida (Fig. 2c). However, the larger plants with lanceolate, acute-tipped leaves that form a whorl of leaves below the inflorescence typically produce short-ovate leaves on the lower stems, although sometimes they will have fallen from the plants by the time of flowering. It seems reasonable to consider the shorter, blunt-tipped leaves as characteristic juvenile foliage of the species. In the collections from the type locality, it appears that flowering occurs on specimens with only juvenile foliage. This can be considered a form of paedomorphosis, i.e. the retention of juvenile characteristics on mature plants. The tendency to flower while having only juvenile leaves is probably fixed genetically. There is also the possibility that if the plant develops late in the season and flowering triggered earlier, the plants may have only produced the shorter, basal leaves by the time of flowering.

In this study, both the ovate-leaved and elliptical-leaved specimens are considered to be the same taxon. One could argue that ovate-leaved and elliptical-leaved specimens represented distinct taxa, but this would not be supported by the presence of plants with both leaf types and the overall continuum of variation from the extreme, represented by the type specimen (Fig. 2a), and other larger specimens from Florida (Fig. 2c) as well as Texas (Fig. 3a).

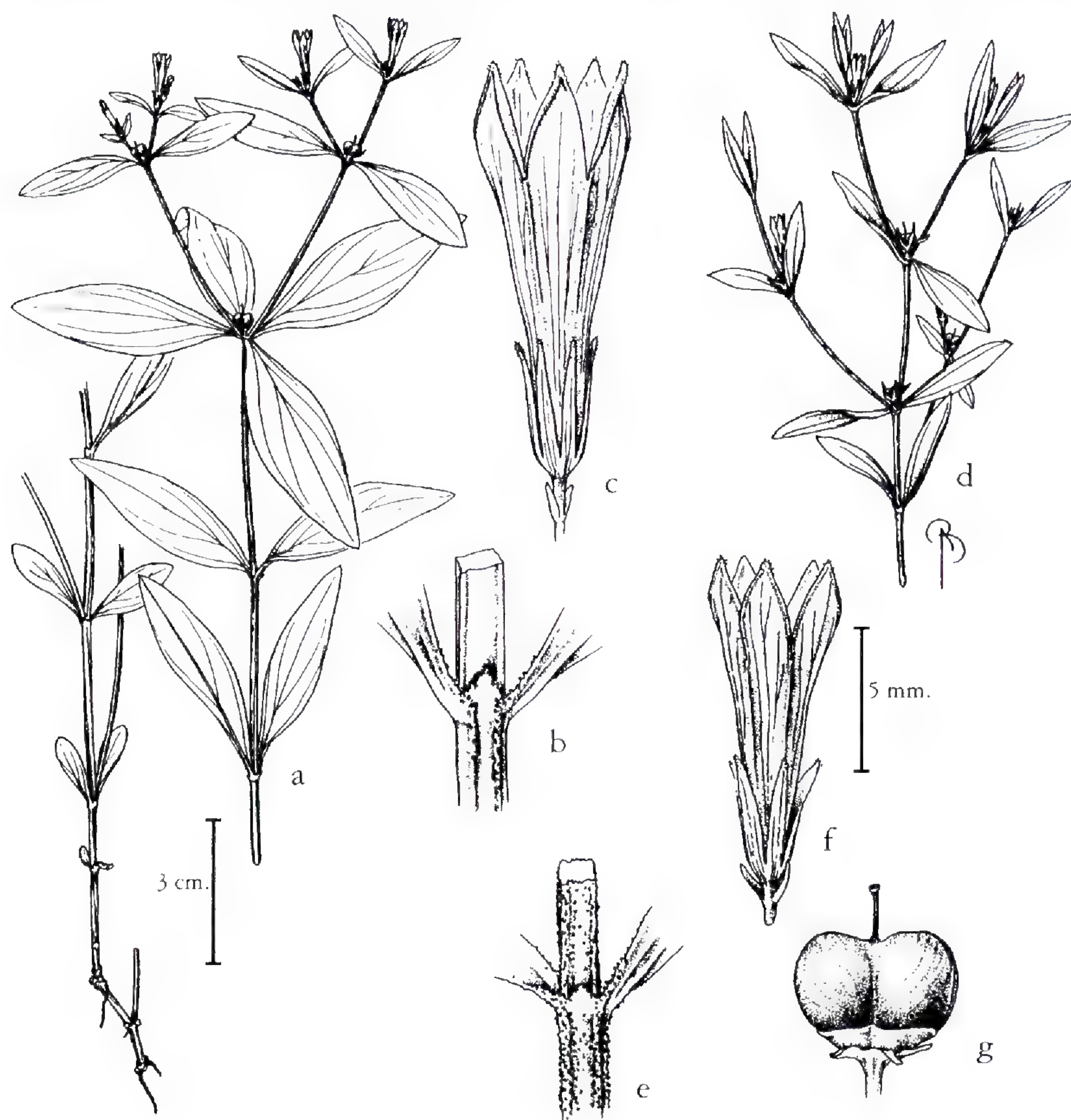


FIG. 3. *Spigelia loganioides* and *S. hedyotideia* from Texas and Mexico. A–C. *S. loganioides* from Texas. A. Stem showing paired large cauline leaves, quartet of leaves subtending first flower of dichasia, leaves, fruits, and flowers in upper branches of dichasia. B. Node showing deltate stipule, leaf bases, and distinct decurrent ridges extending down glabrous internodes (A–B from Killip 43289, TEX). C. Flower showing bractlets, calyx and corolla (Correll & Johnston 17503, LL). D–G. *S. hedyotideia* from Texas. D. Stem showing smaller opposite leaves, dichotomously branched inflorescences, flowers, and fruit. E. Node showing deltate stipule, leaf bases, and decurrently ridged internodes with distinctive scabrous papillae on ridges and lower leaf margins (D–E from Smith 507, TEX). F. Open flower showing bractlets, calyx, corolla; note broader sepals. g. Fruit showing paired cocci, remnants of calyx and nectary at base and persisting style base at fruit tip (F–G from Correll, Rollins & Chambers 16055, LL). Magnifications as indicated, scale with A holds for all stems; scale with F holds for all flowers and fruit.

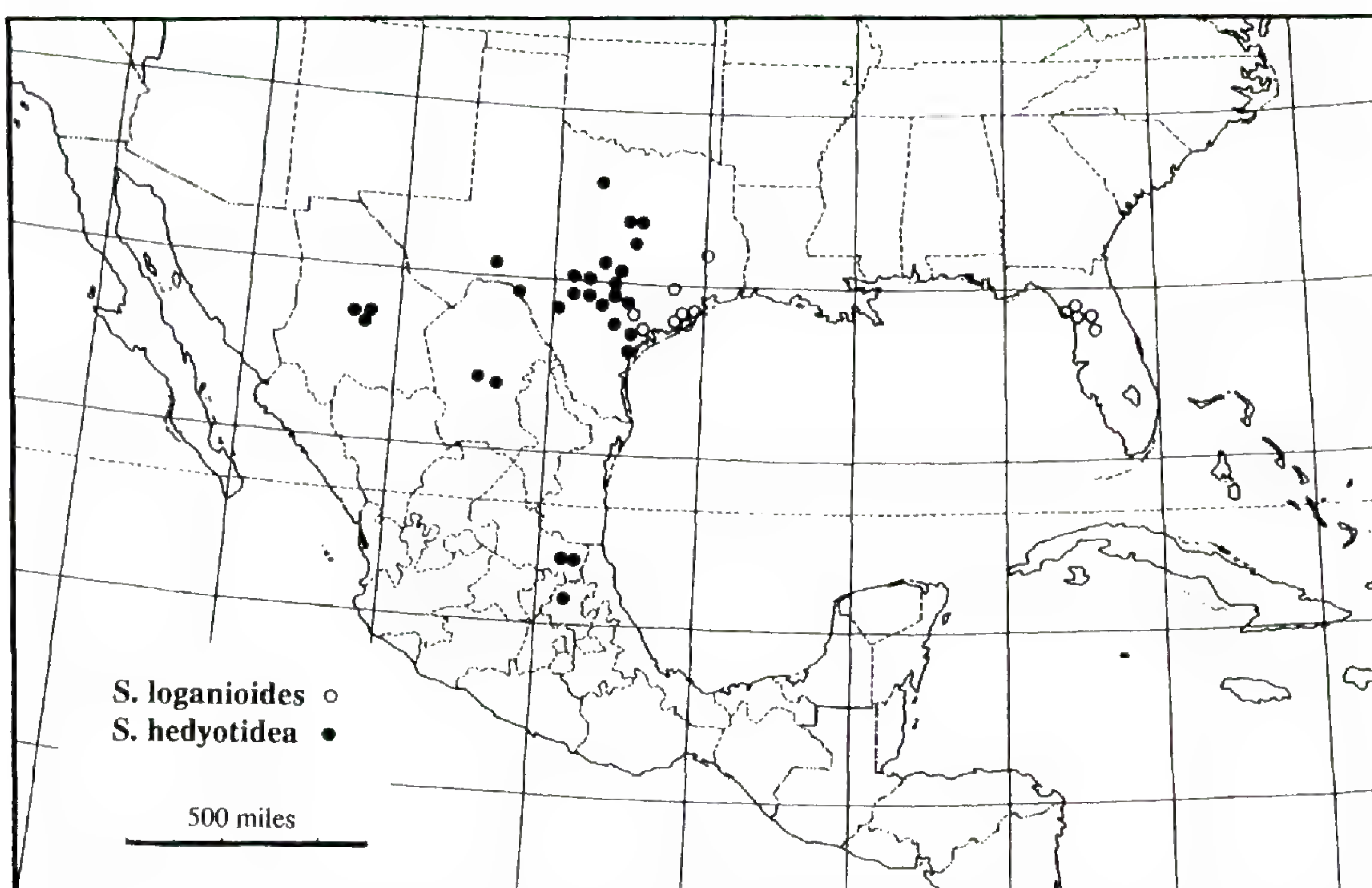


FIG. 4. Documented distribution of *Spigelia loganioides* in Florida and Texas and *S. hedyotideia* in Texas and Mexico.

The plants from Texas known as *Spigelia texana* are identical to those of Florida and are considered conspecific with the older *S. loganioides*. The Texas specimens are more consistently larger with a quartet of leaves below the inflorescences.

The species has a disjunct distribution (Fig. 4); it is known from limestone areas in Levy, Marion and Sumter counties in west-central Florida where it occurs in wet woodlands, hydric hammocks, and floodplain swamps. It also occurs in Brazoria, Colorado, De Witt, Gonzales, Matagorda, Polk, Victoria, Waller and Washington counties in eastern Texas in black-clay soils, thickets, woods along creeks, and riparian forests. Soils in both of these areas are largely derived from limestone and chalk parent material. The taxon does not occur in the broad region between Florida and Texas as limestone-chalky parent material is not present in this region. There are a number of other taxa that have similar disjunct Florida-Texas distributions including *Dyschoriste*, *Cladium*, and *Samolus*.

Representative specimens: U.S.A. FLORIDA. Levy Co.: ca 1 mi SW of Gulf Hammock, T14S, R16E, sec. 29, 3 May 1959, Wood, Wilson & Cooley 9169 (A); Gulf Hammock, 9 May 1941, Merrill s.n. (FLAS); Gulf Hammock, just W of Griffin Creek, T15S, R14E, sec. 8 & 17, 22 May 1980, Judd et al. 2660 (FLAS); 6 mi W of Otter Creek, S of Hwy 24, 5 Jul 1979, Dunevitz 29 (FLAS); 6 mi W of Otter Creek, between Otter Creek and Rosewood, 29 May 1976, Godfrey 76520 (GH, NY, FLAS-photo); Rosewood, Jun 1876, Garber s.n. (FLAS, NY-2, US-2); C.R. 326 at Wekiva Run, E of US 19, 16 Jul 1989, Holland & Mears s.n. (USF). Marion Co.: Oklawaha River, E of Ocala, 10 Apr 1923, Small, Mosier & DeWinkeler 10810 (FLAS, GH, NY, US). Sumter Co.: near Sumterville, Jun, Curtiss 2258

(GH, NY-2, US). **TEXAS.** **Brazoria Co.:** woods along Cedar Lake Creek, San Bernard Natl. Wildlife Ref., 8 May 1970, *Fleetwood* 9753 (TEX); Crowell Ranch, 31 May 1970, *Fleetwood* 9789 (TEX); Lake Jackson, woods along Oyster Creek, 2 May 1953, *Killip* 43289 (SMU, TEX). **Colorado Co.:** Columbia, 5 Oct 1900, *Bush* 1288 (NY, US). **De Witt Co.:** 7 mi SE of Cuero, 6 Jul 1957, *Correll & Johnston* 17503 (LL, TEX). **Gonzales Co.:** Ottine Swamp, 8 Aug 1935, *Parks* 14603 (GH); 4 mi ESE of RR 532 near US 90A, Kokernot Ranch on Peach Creek, 12 May 1991, *Ginsbarg* 941 (TEX). **Polk Co.:** Menard Creek, near Trinity, 28 Apr 1981, *Watson* 3250 (SMU). **Victoria Co.:** Guadalupe River bottom, 29 May 1932, *Tharp s.n.* (TEX). **Waller Co.:** along Brazos River, Stephan F. Austin State Park, near Sealy, 25 May 1957, *Correll* 16444 (LL). **Washington Co.:** Burton, 26 May 1872, *Hall* 288 (NY-3, US).

***Spigelia hedyotide* A.DC.**, Prod. 9:7. 1845. TYPE: MÉXICO: without location, date, *Sessé & Mociño*, plate No. 813 (HOLOTYPE: illustration 813 (deCandole's number) at G (microfische!), photo of holotype F!, US! Described by A. deCandole from a copy of a Sessé and Mociño drawing, which remains at G, with photographs at F and US. No original drawing is present at the Hunt Institute for Botanical Documentation (Kiger, pers. comm.; see Kiger 1981; McVaugh 1982). Two fragments of authentic Sessé and Mociño material labeled *Spigelia axillaris* n., No. 58 and No. 392 were found in F, these fragments were presumably removed from specimens borrowed from MA (McVaugh 1977, 1980). The "axillaris" combination was not published in either *Flora Nuevo Hispanica* (1878–1891) or the *Flora Mexicana* (1891–1897). These specimens exactly agree with the illustration upon which *S. hedyotide* is based and are comparable to *S. lindheimeri* A. Gray; their source from México is discussed below.

Spigelia lindheimeri A.Gray, Syn. fl. N. Amer. 2(1):108. 1878. *Coelostylis lindheimeri* (A.Gray) Small. Fl. s.e. U.S. 922. 1903. TYPE: U.S.A. TEXAS. Comal Co.: New Braunfels, rarely on black silt soil, damp prairies, Jun 1846, *F. Lindheimer* 172 (LECTOTYPE, here designated, GH!). Gray's (1878) citation of the locality as "Prairies of W. Texas, Lindheimer, Wright" made available many annotated syntypes at GH; the designated lectotype has an attached note from Lindheimer stating "distinct from *S. texana*?, fls. apparently half as large." The specimen has narrow to broad, relatively large lanceolate leaves, mature fruit, and seeds.

Spigelia coulteriana Benth., J. Linn. Soc., Bot. 1:90. 1857. TYPE: MÉXICO. HIDALGO: Zimapán, *Coulter* 962. (HOLOTYPE: K!, photo of holotype: NY!). Long considered a species having pseudospicate inflorescences, close examination of the type reveals that the nodes have 2 flowers and belong within *Coelostylis*.

Multistemmed, often decumbent, bushy herbs 5–15(–19) cm tall; stems usually scabrous with erect, stiff, papillae 0.05–0.07 mm long throughout the decurrent internodal wings and usually on the internode surfaces between the wings, on the stipules and upper leaf surfaces or margins; internodes (0.6–)1.5–3.5 cm long. Leaves all opposite, very rarely in whorls of 4 below the inflorescence, the lowermost leaves usually ovate, obtuse to rounded at the tips, to 15 mm long, petiolate, the lower mid stem leaves often oblanceolate, obtuse, the mid- and upper-stem leaf blades lanceolate, narrowly lanceolate, lance-elliptic, (1.2–)1.5–3(–3.5) cm long, 0.3–1(–1.3) cm wide, acute, apiculate at the tip, (sometimes all leaves oblong-ovate,

and blunt tipped) the blades narrowly cuneate, tapering to short petiole-like base 1–3(–4.5) mm long, the margins entire to undulate, often revolute or enrolled when dry, the blades often stiff and coriaceous, the upper surface strongly punctate with cystoliths and with stiff-walled papillae particularly along the margins, typically appearing wrinkled when dried, the lower surface glabrous, gray-green (in shaded plants the leaves often more membranous). Flowers produced in terminal, leafy dichasia with two flowers per node, the shorter flower with an ebracteolate pedicel 1–3 mm long, the taller lateral flower with a bracteate peduncle-pedicel 6–10(–14) mm long, the bractlets subulate-linear, 2.5–7 mm long, 0.4–0.6 mm wide; sepals linear, linear-lanceolate, 3.4–8.5 mm long, 0.5–1(–1.5) mm wide at base, acute at tip, often scabrously papillate along the margins and sometimes along the midveins; corollas white, suffused or lined with pink externally, funnelform, 10–13.5 mm long, the tubes cylindrical to slightly ampliate, (5–)7–9 mm long, to 2–3.5 mm wide at the throat, the lobes obliquely oblong-lanceolate, 3–4.8 mm long, 1.5–1.9 mm wide; stamens borne in the mid-upper corolla tube, the filaments 0.9–1.2 mm long, the anthers 1.0–1.2 mm long; styles 6–7 mm long, the persisting style base 1.2–2 mm long. Fruit cocci 2, nearly spheroid, very slightly divergent, glabrous, the pair 2.5–3.7 mm high, 5–6 mm wide; subtending thickened disk 3.2–3.5 mm wide, 3.5–5 mm long; seeds 6–7 per cocci, 1.5–2 mm long, 1.2–1.6 mm wide (Figs. 3d–g, 4).

Spigelia bedyotidea can be distinguished from *S. loganioides* in that *S. bedyotidea* has: (1) a smaller, bushy growth habit with many stems developing from the basal rootstock; (2) a much smaller, mostly narrowly lanceolate, often thicker leaves that are usually papillate and rather strongly wrinkled on the upper blade surface when dry; (3) a more strongly papillate epidermis with papillae occurring throughout the internode wings (not just below the nodes), and usually over much of the internode surfaces, on the upper-leaf surfaces and stipules; (4) consistent opposite leaves; it only rarely forms a whorl of four leaves below the inflorescences; and (5) narrower, less ampliate corolla tubes.

However, *S. bedyotidea* is quite variable and there many exceptions to the above-noted characteristics. While open-grown plants typically are short and bushy with rather firm, coriaceous leaves, plants collected in shady habitats tend to have longer internodes, less coriaceous, and often larger leaves that may press flat and appear quite smooth and membranous in specimens. Some specimens have short, broadly ovate, more strongly petiolate leaves throughout the stem (reminiscent of the condition in Florida with the type of *S. loganioides*). The plants from San Luis Potosí and Hidalgo, and some from Texas, are quite glabrous with papillae occurring only along

the lower margins of the leaves, on the stipules, but they typically occur all along the internode wings.

The small, more glabrous specimens from San Luis Potosí appear very much like specimens of *S. coulteriana*, a species long considered to range from Hidalgo to Guatimala (Gibson, 1969). However, the specimens from southern Mexico and Central America have elongate pseudospicate inflorescences characteristic of the true *Spigelia*s. Careful examination of the type of *S. coulteriana* from Zimapán, Hidalgo, revealed an inflorescence type characteristic of the *Coelostylis* group and thus *S. coulteriana* is here considered synonymous with *S. bedyotidea*. While most specimens of *S. bedyotidea* are strongly papillate, the type of *S. coulteriana* is very weakly papillate. It is not possible to use this characteristic to recognize two taxa here as many other Mexican collections are also weakly papillate, as are some collections from Texas.

The oldest name for this taxon turns out to be *Spigelia bedyotidea* A.DC described in the *Prodromus* in 1845 from a drawing from Sessé and Mociño in possession of deCandolle. The holotype of the taxon remains the drawing of the species at G. Original Sessé and Mociño herbarium collections of this taxon presumably exist at MA, and fragments at F. The collected specimens are very similar to the type specimens of *S. lindheimeri*. It is not known exactly where the collected material was obtained for neither Sessé or Mociño visited areas where this species grows (McVaugh 1977). McVaugh (1977, p. 110), however, notes that at least two other Sessé and Mociño species were obtained from the Texano-Mexican frontier region from Ignacio León, a pharmacist, who sent seeds and plants to Sessé from his station in Valle de Santa Rosa, (Santa Rosa de Múzquiz) now known as Múzquiz, Coahuila. This is well within the range of the taxon and probably is the source of the material in the Sessé and Mociño herbarium and the source of the illustration, a copy of which was used by deCandolle in his original description.

The taxon is known from open gravelly, sandy clay loams, dark-soiled prairies, limestone slopes, limestone bluffs on generally dry soils in chaparral thickets, mesquite thickets, mixed desert scrub, shaded woodlands, river banks, and rocky creek beds, from central Texas to Chihuahua and Coahuila, San Luis Potosí and northern Hidalgo in México. Specimen data indicates that the flowers are closed in the morning (McVaugh 8342) and open in the afternoon (Jones 537).

Representative specimens: U.S.A. TEXAS. **Bandera Co.:** Hill Country State Natural Area, 29°38'48"N, 99°12'45"W, 4 May 1995, *Carr 14586* (TEX). **Bell Co.:** near Little River, 13 May 1930, *Wolf 2110* (US). **Bexar Co.:** mesquite thickets, San Antonio, Apr 1884, *Havard 13* (GH). **Comal Co.:** New Braunfels, May–Jun 1847, *Lindheimer 43* (GH). **Guadalupe Co.:** Seguin, 28 Apr 1942, *Parks 39529* (TEX). **Hayes Co.:** San Marcos, 1 Jun

1917, *Palmer* 12122 (NY, US). **Karnes Co.:** 5.5 mi SW of Karnes City, 19 Apr 1957, *Correll, Rollins & Chambers* 16055 (LL). **Kendall Co.:** shady woodland below Edge Falls, 3 May 1947, *Tharp, Mericle, & Barkley* 17T139 (GH, TEX). **Kerr Co.:** Kerrville, 7–14 May 1894, *Heller* 1719 (NY, US). **McLennan Co.:** Middle Bosque, 1st crossing, north bank, 2 May 1947, *Smith* 507 (TEX). **Palo Pinto Co.:** hills above Possum Kingdom State Park, 17 May 1947, *McVaugh* 8342 (SMU, TEX). **San Patricio Co.:** 7.5 mi S of Taft, 29 May 1951, *Jones* 537 (SMU). **Terrell Co.:** Creek bed, Independence Creek, 1 mi above its junction with Pecos River, 22 Jun 1949, *Webster* 392 (TEX). **Tom Greene Co.?:** Middle fork of Rio Concho, Apr 1886, *Reverchon s.n.* (GH). **Travis Co.:** Austin, 9 May 1936, *Tharp s.n.* (TEX-2). **Uvalde Co.:** Uvalde, 11 May 1918, *Palmer* 13565 (US). **Val Verde Co.:** bank of Devil's River at Fawcett Lodge, 20–30 mi up river, 3 Apr 1953, *Warnock* 11345 (LL, SMU).

MEXICO. Chihuahua: Santa Eulaia (sic.) Mts., 1 May–6 Jun 1885, *Pringle* 25 (GH); Sierra del Roque, NNE of Julimes above Mina Las Playas, 28°39'–40'N, 105°18'–19'W, 19 Jun 1973, *Johnston, Wendt, & Chiang* 11389A (LL). **Coahuila:** Sierra de la Madera, Cañón de la Madera, 1890 m, 27°07'N, 102°37'W, 29 May 1975, *Wendt & Lott* 842A (LL); Sierra de la Gloria, Cañón El Cono, a side canyon of Cañón Chilpitin, 1160 m, 26°49'N, 101°17'W, 6 Sep 1976, *Wendt & Riskind* 1654 (TEX). **San Luis Potosí:** San Dieguito, 13–16 Jun 1904, *Palmer* 86 (NY, US-2); Mpio. Valles, Río Valles at El Banito, 7 mi S. Valles, 26 Jun 1940, *Leavenworth* 183 (F).

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BOOK NOTICES

LADD, DOUG. 1995. **Tallgrass Prairie Wildflowers.** (ISBN 1-56044-299-9, pbk). Falcon Press Publishing Company, P.O. Box 1718, Helena, MT 59624. \$19.95. 262 pp.

"This guide covers the more common and characteristic plants of tallgrass prairies from northeastern Oklahoma north into Canada and eastward through Ohio. Included ... are [about 320] photographs [by Frank Oberle] ... of 295 tallgrass prairie plants, including a few examples of very rare plants that epitomize the tallgrass prairie." The seven main sections of the book, which present the wildflowers arranged by flower color, follow the standard introductory material (e.g., description of area covered and plant morphology) and precede the glossary, a useful "Tallgrass Prairie Directory," "Selected Further Reading," and an index. Accompanying each photograph is text describing the plant, flowering time, and habitat/range. The photos (one or two per page) are, almost without exception, superb; in conjunction with the brief descriptions, they will make identification of the target plants an easy task. This book should be required equipment for anyone visiting the tallgrass prairie. Even elsewhere, though, it is a pleasure to read through.—*John W. Thieret.*

DUNMIRE, WILLIAM W. and GAIL D. TIERNEY. 1995. **Wild Plants of the Pueblo Province. Exploring Ancient and Enduring Uses.** (ISBN 0-89013-272-0, pbk.). Museum of New Mexico Press, P.O. Box 2087, Santa Fe, NM 87504. \$19.95. 290 pp.

"A region of enormous diversity," "The ancestral Puebloans," "Contact, Colonization, and Catastrophe," "Modern descendants," "Indicator plants as living artifacts," "Plants and plantcraft," "Ethnobotany in New Mexico," "Recent modifications in the landscape," and "Other places to visit," these chapter titles indicate the wide and full coverage of this fine production, an exemplary historico-ethnobotanical volume. Abundantly illustrated, the work is well produced and well indexed. Coverage of relevant literature is good (146 references in the "Bibliography") "Plants and plantcraft," the book's longest section (141 pages), considers 55 of the most important species, each with its own text, color photo, and line drawing. Data on these species plus about 240 others are conveniently summarized in a 12-page table. The authors and the Museum of New Mexico Press have done a superb job.—*John W. Thieret.*

RICHARDSON, ALFRED. 1995. **Plants of the Rio Grande Delta.** (ISBN 0-292-77070-7, pbk). University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819. Price not indicated. 332 pp.

This volume "expands and updates" Dr. Richardson's *Plants of Southermost Texas* (1990), an identification guide to the flora (excluding the grasses) of Cameron, Hidalgo, and Willacy counties (see notice in *Sida* 15:170. 1992). Most of the text is a repeat of that in the earlier work, but new and welcome indeed is the array of 94 beautifully reproduced color plates bound together at the end of the book. They greatly increase the book's value for its stated purpose.—*John W. Thieret.*

A NEW COMBINATION IN *ERAGROSTIS* (POACEAE: ERAGROSTIDEAE)

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ABSTRACT

The new combination *Eragrostis pectinacea* var. *tracyi* is proposed as a more appropriate means of recognizing the slight morphological difference of possessing longer anthers. A revised key to the three varieties of *E. pectinacea*, a diagnosis of var. *tracyi*, and specimens examined are provided.

RESUMEN

Se propone la nueva combinación *Eragrostis pectinacea* var. *tracyi* como más apropiada para reconocer las ligeras diferencias morfológicas de tener anteras más largas. Se ofrece una clave revisada de las tres variedades de *E. pectinacea*, una diagnosis de la var. *tracyi*, y los especímenes examinados.

The genus *Eragrostis* consists of approximately 350 species worldwide and, of these, about 120 species are represented in the western hemisphere (Peterson et al., in press). The present biogeographical pattern supports the hypothesis that the genus arose in the Old World, probably in southern Africa where it is most speciose. The best combination of characters used to discriminate *Eragrostis* from other Eragrostideae is: disarticulation of the lemma and palea occurring separately; longitudinally bowed-out paleas with ciliolate keels; and 3-nerved, unawned lemmas. Within *Eragrostis* the species limits are often overlapping. Few agrostologists have attempted to work out a suitable phylogenetic scheme. Based on 442 morphological and anatomical characters, and using a worldwide sample of 53 species, Van den Borre and Watson (1994) recognized two subgenera, *Eragrostis* and *Caesia*. The new combination appears to reside in the former.

While preparing the *Eragrostis* treatment for the new *Manual of North American Grasses*, Edited by M. Barkworth, (Peterson & Harvey, in press) I became aware of the similarities between *E. tracyi* Hitchc. and the common purple lovegrass [*E. pectinacea* (Michx.) Nees]. The following paper provides a rationale for the new combination of *E. pectinacea* var. *tracyi* (Hitchc.) P.M. Peterson.

Hitchcock (1934) first described *E. tracyi* from specimens collected by S.

M. Tracy on Sanibel Island. In his paper he wrote, "apparently perennial" and in his Latin description he indicated "Perennis (?)." Koch (1972) re-evaluated *E. tracyi* and found it to be an annual with a hexaploid chromosome number of $n = 30$, $x = 10$. Koch (1972, 1978) concluded that *E. tracyi* was closely related to *E. lutescens* Scribn., *E. pectinacea*, and *E. tephrosanthos* Schult. Koch (1972) found that *E. tracyi* could be distinguished from these other species by its larger anthers. *Eragrostis pectinacea* and *E. tephrosanthos* have previously been determined to be hexaploids at $n = 30$, $x = 10$ (Koch 1974). More recently, Reeder (1986) recognized two varieties in *E. pectinacea*, var. *pectinacea* and var. *miserrima* (E. Fourn.) Reeder. The latter variety includes *E. tephrosanthos* as a synonym. I agree with Reeder's treatment of placing *E. tephrosanthos* as a synonym of *E. pectinacea*. *Eragrostis pectinacea* is a highly variable taxon as described by Koch (1974). Anther length is the only morphological characteristic that can be used to differentiate *E. tracyi* from *E. pectinacea* (0.5–0.7 mm long in the former and 0.2–0.4 mm long in the latter). To remain consistent with the new broader delimitation of *E. pectinacea* and since a single morphological trait separates these two taxa, I feel that *E. tracyi* should be reduced to the varital rank of *E. pectinacea*. A key to the three varieties of *E. pectinacea*, a diagnosis of var. *tracyi*, and specimens examined in the U.S. Herbarium are given below.

KEY TO THE VARIETIES OF *ERAGROSTIS PECTINACEA*

1. Anthers 0.5–0.7 mm long var. **tracyi**
2. Anthers 0.2–0.4 mm long.
 2. Pedicels appressed or rarely diverging up to 20° from the branches var. **pectinacea**
 2. Pedicels widely spreading var. **miserrima**

***Eragrostis pectinacea* (Michx.) Nees var. *tracyi* (Hitchc.) P.M. Peterson, comb. nov.** *Eragrostis tracyi* Hitchc., Amer. J. Bot. 21:130. 1934. TYPE: U.S.A. FLORIDA. Lee Co.: Sanibel Island, 19 May 1901, *Tracy* 7168 (HOLOTYPE: US!; ISOTYPE: US!).

Panicles with spreading branches 20–80° from the culm axis. Anthers 0.5–0.7 mm long.

Ecology and Distribution.—Sandy soils, along shell beaches, and roadsides; associated with *Eragrostis ciliaris* (L.) R. Br., *Agave*, *Juniperus*, *Sabal*, and *Yucca*; 0–30 m elevation; Lee, Manatee, Pinellas, and Sarasota cos., Florida; flowering March through May and August through December.

Common Name.—Sanibel lovegrass.

Representative specimens (all at US). U.S.A. Florida. Lee Co.: Sanibel Island, Jul-Aug 1900, *Hitchcock s.n.*; 28 Dec 1953, *Cooley* 2495; 13 Apr 1954, *Cooley* 2608; 11 Mar 1971, *Koch* 7123; Western Sanibel, *Brumbach* 7721, 3 Nov 1971; Eastern Sanibel, *Brumbach* 7767, 13 Dec 1971. Mantee Co.: Anna Maria Key, 24 Sep 1968, *Harvey* 8174; Longboat Key, 27 Apr 1900, *Tracy* 6709; 24 Sep 1968, *Harvey* 8177; 9 Mar 1971, *Koch* 7113; 23 Aug 1971,

Godfrey 70891. Sarasota Co.: Longboat Key, 6 Oct 1964, *Lakela* 27566; 21 Nov 1964, *Godfrey* 65243; Venice City, 10 Mar 1971, *Koch* 7116.

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BOOK NOTICES

SWANSON, ROBERT E. 1994. **A Field Guide to the Trees and Shrubs of the Southern Appalachians.** (ISBN 0-8018-4556-4, pbk.). The Johns Hopkins University Press, 2715 North Charles Street, Baltimore, MD 21218-4319. \$18.95 (pbk); \$55.00 (hbk). 399 pp.

The area covered by this work is "the mountains and higher foothills of western North Carolina, upper South Carolina, Northeast Georgia, and Great Smoky Mountains National Park." Well accounted for in this book are the area's 180 genera and 280 species of woody plants. An introductory section covers morphological features useful in identification. Carefully constructed keys are provided for both summer and winter identification. Arranged by families, the main part of the book is devoted to clear illustrations (black-and-white line drawings by Frances R. Swanson) and detailed descriptions of the various species. The volume closes with a glossary, a list of references (10 of them), and an index. I recommend the work to anyone planning a visit there. It worked well for those 20 species I chose as test cases. Kudos to the author.—*John W. Thieret.*

DAHMER, FRED. 1995. **Caddo was ... A short History of Caddo Lake.** (ISBN 0-292-72479-9, pbk.). University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819. \$8.95 80pp.

Caddo Lake, the largest natural freshwater lake in Texas, covers ca. 26,800 acres and straddles the Texas/Louisiana border. This book on various aspects of the lake's history, was first published as a series of essays in the 1980s, then as a book in 1988, and now as a "revised" edition in 1995. It includes but little botany, not claiming to be a source of data on the lake's biota. Some of the photographs (all black and white) are of magnificent, Spanish-moss-draped bald-cypresses; and a short chapter has a few data on duckweeds, waterlillies, goldenclub, spatterdock, and American lotus. Having been many times to Caddo Lake, I enjoyed reading *Caddo was*.—*John W. Thieret.*

A NEW COMBINATION IN *BOUTELOUA* (POACEAE)

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ABSTRACT

The new combination *Bouteloua hirsuta* Lag. subsp. *pectinata* (H. Featherly) J. Wipff & S.D. Jones is proposed. A key to the two subspecies is provided.

RESUMEN

Se propone la nueva combinación *Bouteloua hirsuta* Lag. subsp. *pectinata* (H. Featherly) J. Wipff & S.D. Jones. Se ofrece una clave de las dos subespecies.

***Bouteloua hirsuta* M. Lagasca y Segura subsp. *pectinata* (H. Featherly) J. Wipff & S.D. Jones, comb. et stat. nov.** BASIONYM: *Bouteloua pectinata* H. Featherly, Bot. Gaz. 91:103. 1931. *Bouteloua hirsuta* var. *pectinata* (H. Featherly) V. Cory, Rhodora 38:405. 1936. TYPE: UNITED STATES. OKLAHOMA. Comanche Co.: near Fort Sill, 17 Aug 1929, *B. English* 71 (HOLOTYPE: US).

Bouteloua pectinata, closely related to *B. hirsuta*, has been recognized at various taxonomic ranks: Roy and Gould (1971) and Gould (1975, 1979) recognized this taxon as a distinct species; Cory (1936) recognized it as a variety of *B. hirsuta*; and Hitchcock (1935) and Chase (1951) treated it as a synonym of *B. hirsuta* without any infraspecific rank. The two taxa can be distinguished by the following characters (Roy & Gould 1971):

1. Tuft of trichomes present at the base of the lowermost rudimentary floret; anthers ca. 3 mm long; culms 37–75 cm tall, strictly erect, unbranched, usually with three nodes; the inflorescence axis 25–40 cm long (above uppermost culm leaf) subsp. ***pectinata***
1. Tuft of trichomes absent at the base of the lowermost rudimentary floret; anthers 2–2.5 mm long; culms 15–40 cm tall, decumbent at base, usually branched, with 4–6 nodes; the inflorescence axis 10–30 cm long (above uppermost culm leaf) subsp. ***hirsuta***

A biosystematic study of *B. pectinata* and *B. hirsuta* by Roy and Gould (1971) resulted in the following conclusions: 1) *B. pectinata* is restricted to well-drained, relatively undisturbed calcareous soils and is most frequent on thin-soiled limestone outcrops, occurring from Pontotoc and Comanche counties, Oklahoma, south to Uvalde County, Texas; 2) *Bouteloua hirsuta*,

found in a wide variety of habitats, is widely distributed and occurs from Wisconsin and Illinois to North Dakota, south to Louisiana, Texas, New Mexico, Arizona, southern California, and northern México; 3) the morphological uniformity of *B. pectinata*, $2n = 20$ populations contrasts strikingly to the morphological variability observed in the diploid plants $2n = 20$, of *B. hirsuta*. Usually associated with diploid *B. hirsuta* are plants with widely varying chromosome numbers, e.g. $2n = 22, 24, 26, 28, 30, 32, 34, 36, 40, 42, 43, 44, 45, 46, 48, 50, 52, 53, 54, 56, 58$, and 60 (Roy 1968); 4) where populations of the two taxa are sympatric, swarms of putative hybrid plants are found that are intermediate in some or all of the critical morphological characteristics; and 5) for the most part, these putative hybrid swarms are found only along the margins of typical *B. pectinata* sites (when populations of *B. hirsuta* are also present). Sites in Kendall County, Texas appear to be representative of the ecological distribution and separation of the two taxa. Roy and Gould (1971) stated, "Throughout this area the two species, *B. hirsuta* and *B. pectinata*, were intermingled in slightly disturbed road right of way sites. *Bouteloua hirsuta* predominated at the base of the slopes and in the gulleys [*sic*] and ditches, and *B. pectinata* was most abundant on the ledges and hilltops. Intermediate plants were abundant."

From these data, *B. pectinata* is restricted in its geographic distribution, occupies a specific ecological site, and is generally ecologically allopatric and morphologically distinct from *B. hirsuta*. However, there are putative hybrid swarms at the boundary where the two taxa come in contact. These swarms show an integration of morphological characters between the two taxa indicating a lack of complete reproductive isolation. These data warrant the recognition of *B. pectinata* at the subspecific rank.

We are grateful to W.E. Fox, III (TAES), Stephan L. Hatch (TAES), Gretchen D. Jones (USDA, AWPURU), and Clifford W. Morden for reviewing this manuscript.

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A NEW SUBSPECIES OF *GENTIANELLA* *HETEROSEPALA* (GENTIANACEAE) FROM MEXICO

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ABSTRACT

Collections from northwestern Durango have uncovered the presence of *Gentianella heterosepala* (Engelm.) Holub in Mexico. The species is previously known from the southwestern United States. The Mexican population, described here as subspecies *durangensis*, produces foliaceous calyx lobes joined to the tube and a calyx tube with glandular trichomes between the lobes, corolla fimbriae inserted at the base of the lobes and ovate-auriculate leaves. A morphological description and an illustration are presented.

RESUMEN

Colectas provenientes del noroeste de Durango ponen de manifiesto la presencia de *Gentianella heterosepala* (Engelm.) Holub en México. La especie se conocida previamente del sudoeste de los Estados Unidos. La población mexicana, descrita aquí como subespecie *durangensis*, muestra los lóbulos foliáceos del cáliz unidos al tubo, el tubo del cáliz con tricomas glandulares entre los lóbulos, fimbrias de la corola insertas en la base de los lóbulos y hojas ovado-auriculadas. Se presenta una descripción morfológica y una ilustración de la subespecie.

KEY WORDS: *Gentianella*, Gentianaceae, Durango, México.

The genus *Gentianella* was revised for North America by Gillett in 1957, and recently, Nesom (1991) reported twelve species for México. Specimens of *Gentianella heterosepala* collected from Durango correspond to a new subspecies, increasing the number of taxa represented in México to thirteen.

Gentianella heterosepala was first proposed by Engelmann within the genus *Gentiana* in 1862 based on material from the southwestern United States. Greene (1904) considered it to be a member of the genus *Amarella*; Gillett (1957) later recognized it as a subspecies of *Gentianella amarella*, and more recently Holub (1967) raised it to specific rank. Holmgren (1984) recognized *G. amarella* and *G. heterosepala* as distinct.

***Gentianella heterosepala* (Engelm.) Holub ssp. *durangensis* Villarreal, ssp. nov. (Fig. 1)**

Gentianellae heterosepala (Engelm.) Holub. ssp. *heterosepala* similis sed differt lobis calycis foliaceous unitus ad tubo, inter lobos pili-glanduloso, corollarum fimbriis insertis ad basim lobis, et foliis ovatis valde cordati-auriculatis.

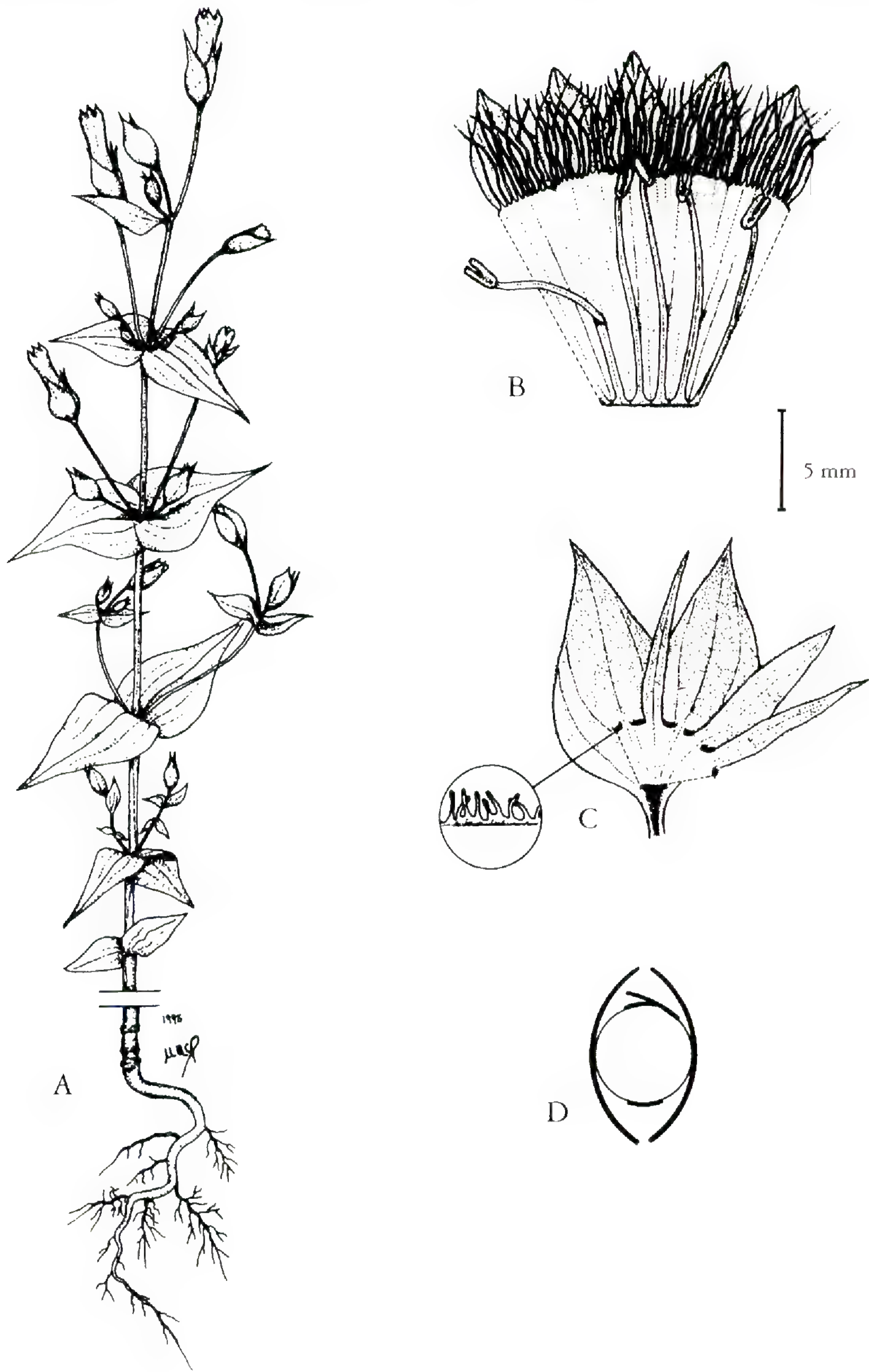


FIG. 1. *Gentianella heterosepala* ssp. *durangensis* A. Habit. B. Corolla. C. Calyx with detail of the tube margin. D. Diagram showing the disposition of the sepals.

Plants annual. Stems erect to decumbent at the base, 30–60 cm tall, glabrous, terete to slightly angled, purplish. Leaves opposite, sessile, subclasping, not basally connate, spreading, 5-nerved, glabrous, ovate, 3–5 cm long, 2–2.5 cm wide proximally, base auriculate, apex acuminate, margin minutely denticulate. Flowers mostly 1–4 in cymes, on narrowly winged pedicels 2–6 cm long, glabrous, terminal on the primary branches and axillary branches arising mostly on the upper 1/3 of the stem; calyx of five sepals, two of them foliaceous, opposite, covering the remaining calyx, ovate, 10–15 mm long, 6–10 mm wide, base cuneate, apex acuminate, trinervate, green, the middle portion joined to the tube, the tube campanulate, 3–5 mm long with glandular trichomes between the lobes, the three lobes lanceolate, 8–10 mm long, 1.5–2 mm wide, one of them 3–5 mm wide, acuminate, trinervate, green at the tips; corolla yellowish with some blue in the lobes, funnelform, the tube 10–12 mm long, with a ring of filaments at the mouth, the lobes ovate, 5–6 mm long; stamens five, the filaments flattened, adnate to the base of the corolla, the anthers dorsifixed, 1.5 mm long, separated at the upper portion. Ovary narrowly elliptic, 1 cm long, stigmas 2; fruit narrowly elliptic, 2–2.5 cm long, 5–6 mm wide.

TYPE. MEXICO. DURANGO: Mpio. Canelas, 28.5 km al sueste de Canelas, por el camino a Durango, bosque de pino, 2650 m, 6 Oct 1985, *Socorro González* 3446, y *M. González* (HOLOTYPE: MEXU; ISOTYPES: ANSM, CIIDIR).

Additional specimens examined: Durango: Mpio. Canelas, 19 km de Canelas, por el camino a Durango, bajío inundable en bosque de pino, 2560 m, 5 Oct 1985, *Socorro González* 3391, *M. González* y *Y. Herrera* (ANSM, CIIDIR). Mpio. Canelas, predio particular Cebollitas, bosque mixto de *Pinus*, *Quercus*, *Pseudotsuga*, *Picea* y *Abies* con presencia de *Pinus durangensis*, *P. ayacahuite*, *P. arizonica*, *P. cooperi*, *Abies durangensis*, *Arbutus xalapensis*, *Juniperus deppeana* y *Cupressus benthamii*, hierba erguida de unos 30 cm alto, flor violeta, abundante, suelo soméro pedregoso oscuro con afloramientos rocosos, pendiente 100%, exposición norte, 2600 m, 25 Sep 1990, *Oscar Bravo Bolaños* 1562 (ANSM, CHAP).

Gentianella heterosepala is a member of the section *Amarella* (Gillett 1957) and is distinguished by a calyx with two bracteate foliaceous sepals that enclose the remaining calyx and portion of the corolla. The inner calyx lobes are usually of different length. The pedicels are 2–7.5 cm long, and the corollas 15–20 mm long. *Gentianella amarella* (L.) Borner ssp. *acuta* (Michx.) Gillett which grows in the same area, has a calyx tube with lobes equal or unequal in width (but not foliaceous, as shown in Figure 1 c–d), shorter pedicels and smaller flowers. The hybridization between the two species is not considered. *Gentianella heterosepala* occurs primarily in the southwestern United States (Utah, Colorado, Idaho, Arizona, and New Mexico), where it grows in meadows, streambanks and open aspen-pine forest at 2000–3400 m (Holmgren 1984).

Gentianella heterosepala ssp. *durangensis* is known in Mexico from the municipio of Canelas in the Sierra Madre Occidental of northwest of

Durango, where it is localized in pine woodlands at 2600–2700 m altitude and disjunct from the southernmost population in the United States by about 600 kilometers. Plants of the Mexican populations are characterized by a calyx tube 3–5 mm long with three lanceolate lobes, and two foliaceous lobes joined on the outside, glandular trichomes on the tube between the calyx lobes, corolla fimbriae inserted at the base of the lobes, and ovate-auriculate leaves (Fig. 1). The United States populations (*G.b.* ssp. *heterosepala*) have a short calyx tube (1–2 mm long) with the foliaceous sepals free to the base, and when present, a rim of glandular trichomes at the middle of the calyx tube. The corolla fimbriae are united in a scale at the base of each lobe, the leaves are usually elliptic-oblong, narrow at the base, and occasionally ovate.

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CONTRIBUTIONS TOWARD A NEW FLORA OF THE PHILIPPINES: I. A SYNOPSIS OF THE GENUS *MYRSINE* (MYRSINACEAE)

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ABSTRACT

A synopsis of the genus *Myrsine* L. is provided for the Philippines, including all species heretofore assigned to the genus *Rapanea* Aublet. Fourteen species are recognized, of which four: *Myrsine densiflora*, *M. cruciata*, *M. aralioides*, and *M. penibukana*, are reported from the archipelago for the first time. *Myrsine aralioides*, *M. penibukana*, and *M. cruciata*, previously thought to be endemic to Mt. Kinabalu, Sabah, are reported for Surigao, Mindanao, Abra and Rizal provinces, Luzon, and northern Palawan, respectively. A key to the species, descriptions, representative photographs and comments on the distribution, ecology and conservation status for each species are provided. Because *Rapanea* is here considered a taxonomic synonym of *Myrsine*, all Philippine species heretofore assigned to *Rapanea* are transferred to *Myrsine*, and new names are proposed for those species whose epithets in *Rapanea* are preoccupied under *Myrsine*. The following new combinations are made: *Myrsine apoensis* (Elmer) Pipoly, *M. oblongibacca* (Merrill) Pipoly, *M. cruciata* (Philipson) Pipoly, *M. penibukana* (Philipson) Pipoly, *M. mindanaensis* (Elmer) Pipoly, *M. fastigiata* (Elmer) Pipoly, *M. aralioides* (Philipson) Pipoly, *M. glandulosa* (Elmer) Pipoly, and *Myrsine peregrina* (Mez) Pipoly. Comparative studies of taxa in nearby Sabah, Brunei, Sarawak and Borneo result in the new combination *Myrsine multibracteata* (Merrill) Pipoly. In addition, two new names are made: *Myrsine medeciloae* Pipoly and *M. amorosoana* Pipoly. Ten binomials are lectotypified and *Rapanea venosa* Elmer *non* (A. DC.) Mez is placed in synonymy under *Myrsine peregrina* (Mez) Pipoly.

RESUMEN

Se ofrece una sinopsis del género *Myrsine* L. para las Filipinas, incluyendo todos los taxa previamente asignados al género *Rapanea* Aublet. Se reconocen catorce especies, de las cuales cuatro, *Myrsine densiflora*, *M. cruciata*, *M. aralioides*, y *M. penibukana*, son nuevas citas para el país. *Myrsine aralioides*, *M. penibukana* y *M. cruciata*, anteriormente fueron consideradas como especies endémicas del Mt. Kinabalu, de Sabah, sin embargo, el presente estudio revela que estas especies se encuentran en las provincias de Abra y Rizal en la isla de Luzón, y en la parte septentrional de la isla de Palawan. Se ofrece una clave de las especies, descripciones, fotos representativas y comentarios sobre la distribución, ecología y estatus de conservación para cada especie. Debido al hecho de que se considera el género *Rapanea* como un sinónimo taxonómico del género *Myrsine*, todas las especies previamente asignadas al género *Rapanea* se transfieren al género *Myrsine*. Para las especies con epítetos previamente ocupados en *Myrsine*, se forman epítetos nuevos. Se proponen las siguientes nuevas combinaciones: *Myrsine apoensis* (Elmer) Pipoly, *M. oblongibacca* (Merrill) Pipoly, *M. cruciata* (Philipson) Pipoly, *M. penibukana* (Philipson) Pipoly, *M. mindanaensis* (Elmer) Pipoly, *M.*

fastigiata (Elmer) Pipoly, *M. aralioides* (Philipson) Pipoly, *M. glandulosa* (Elmer) Pipoly y *Myrsine peregrina* (Mez) Pipoly. Estudios comparativos de las especies de Sabah, Brunei Sarawak y Borneo dan como resultado la nueva combinación *Myrsine multibracteata* (Merrill) Pipoly. También, se proponen dos nombres nuevos: *Myrsine medeciloae* Pipoly y *Myrsine amorosoana* Pipoly. Se lectotipifican diez binómenes y se relega *Rapanea venosa* Elmer non (A. DC.) Mez, a la sinonimia de *Myrsine peregrina* (Mez) Pipoly.

INTRODUCTION

As part of the Flora of the Philippines Project, jointly undertaken by BRIT and the Philippine National Herbarium, a revision of the Philippine species of *Myrsine*, including those taxa formerly assigned to *Rapanea*, was undertaken. The genus is now defined as pantropical, with approximately 300 species, of which nearly 1/4 remain undescribed. *Myrsine* is the type genus of the tribe *Myrsineae*, defined by its uniseriate ovules and imbricate or valvate perianth aestivation. Recent studies (Pipoly 1992b, 1994) have shown that the principal technical characters defining the tribe are found rather at random in the tribe *Ardisieae*, and biseriate ovules are most common in the genus *Parathesis* Hooker f., and *Stylogyne* A. DC. Therefore, a worldwide generic monograph is needed before long-term nomenclatural stability is established. Pipoly (1991a, 1992a, 1992b) and Pipoly and Chen (1995) have shown that characters traditionally used to separate *Rapanea* from *Myrsine* grade and therefore cannot be used with confidence to define either group unequivocally, and have begun the process of transferring all species of *Rapanea* into *Myrsine*.

NOMENCLATURAL HISTORY AND SYSTEMATIC POSITION OF MYRSINE

The genus *Myrsine* Linnaeus, as here defined, includes *Rapanea* Aublet and *Suttonia* A. Richard, among other genera rarely recognized today (see Taxonomic Treatment). While no modern author has considered maintaining *Suttonia* (except Rock 1974), the discussion of the systematic position of species heretofore assigned to *Rapanea* has varied considerably from one author and world region to another.

The first monographer of the family, Alphonse de Candolle, proposed uniting *Rapanea* with *Myrsine* in his generic level reviews of the family (1834a, 1834b), which he consistently followed in later "memoirs," or analyses of the generic and tribal taxonomy of the family (1841a, 1841b), as well as in his contribution to the DC Prodrômus (1844). Koorders and Valenton (1900) followed the De Candolle philosophy in their treatment of the family for Java. Mez (1901, 1902) separated *Myrsine* from *Rapanea* based on the obvious style on the pistil and pistillode with obvious filaments of the stamens and staminodes in the former, and an apparently

obsolete style with sessile anthers or antherodes (sterile anthers or ones that produce non-viable pollen) in the latter. Subsequently, in the most comprehensive revision of the family covering Asian species since Mez, Walker (1940) maintained *Rapanea* as a genus distinct from *Myrsine*, by essentially paraphrasing Mez, a view concurring with Standley (1938) and Degener (1939). Oliver (1951) followed Degener as did Bâthie (1953). However, Walker's treatment of the group for Taiwan (1959) concluded that the two genera were in fact, synonymous, following the argument proposed by Hosaka (1940). Later, Li (1963, 1978) Meyer and Walker (1965), Wilbur (1965) and Backer and Bakhuizen van de Brink (1965) also followed Hosaka. Lundell (1966, 1971) in his treatments of the family for Guatemala and Panama, followed Mez's arguments, but did not provide specific details to refute the transfers made by Stearn (1969) who was the first modern author treating tropical American taxa to synonymize *Rapanea* within *Myrsine*. Liogier (1971, 1989) who had earlier recognized *Rapanea* in his treatment of the Myrsinaceae for the Flora de Cuba (1959), also followed Stearn. Indeed, Lundell (1981) recognized *Rapanea* as synonymous with *Myrsine*, "to follow current practice, not out of any conviction as to the justification for this disposition of the taxa !" Subsequently, Lundell (1984) described two new neotropical species in *Myrsine*.

The most cogent argument presented in the recent literature for maintaining *Rapanea* as distinct from *Myrsine* is that of A. C. Smith (1973, 1981), who based his decision on the fact that the *Rapanea* species he was familiar with did not have the "flange," or apically free staminal tube, present in *Myrsine africana* L., the type species of *Myrsine*, but rather, the staminal tube was developmentally fused with the corolla tube such that the anthers appeared epipetalous. Smith's philosophy was largely that of Degener (1939) and Oliver (1951) but neither of those authors had so eloquently stated their rationale. Sleumer (1986) followed A. C. Smith's concept in his treatment of the taxa for New Guinea, as did Fournet (1978) for Guadeloupe and Martinique, Taton (1980) for Central Africa, Kupicha (1983) for the Zambesiaca Region, Halliday (1984) for Tropical East Africa, Little et al. (1988) for Puerto Rico and the Virgin Islands, and Green (1986, 1990) for the Norfolk and Lord Howe Islands' taxa.

On the other hand, Fosberg and Sachet (1975, 1980), and Sachet (1975) discussed their philosophy for including *Rapanea* within *Myrsine*, largely because they considered the staminal tube difference the only character separating the two groups. They proposed that the *Rapanea* group *sensu stricto* be recognized as a section within *Myrsine*, but did not formalize that position nomenclaturally. Correll and Correll (1982), Liogier (1989), Howard (1989), Nicholson (1991), and Guzmán-Teare (1992) all followed

Stearn (1969) and the Fosberg and Sachet papers. Wagner et al. (1990) presented essentially the same argument as Fosberg and Sachet (1975), but allowed for the possibility that future, geographically broad studies, might reveal that a small staminal tube difference may in fact, be important.

Based on the study of at least representative taxa for the genus worldwide, Pipoly (1991a, 1992a, 1992b), Pipoly and Chen (1995), Harvey and Pipoly (1995), and Chen and Pipoly (in press), along with my unpublished work, have shown that the species previously placed in *Rapanea*, including the type species, *R. guyanensis* Aublet, have two vascular traces in the lower corolla tube, such that the removal of an anther from the corolla results in the tearing of the adaxial surface of the corolla tube without detaching the corolla lobe. As Pipoly (1981, 1983a, 1983b, 1987, 1988, 1991b, 1991c, 1992c, 1992d, 1993, 1994) has demonstrated in the neotropical genus *Cybianthus*, a transitional series from a staminal tube free from the corolla tube to one where the staminal tube is morphogenetically fused in its entirety is easily seen within one myrsinaceous genus. In addition, new Venezuelan, Colombian, and Peruvian species of *Myrsine* recently described by Pipoly (1991a, 1992a, 1992b) clearly show that some taxa possess filaments totally free from each other and also from the corolla tube, others have filaments briefly connate basally, but free from the adaxial corolla tube (thus, a "flange"), others again have filaments partially connate but wholly adnate to the adaxial corolla tube and lobe surfaces, and finally, still others have lower portions of the filaments forming a tube morphogenetically fused to the corolla tube, as well as having the upper portions of the same filaments morphogenetically fused to the corolla lobes. Clearly, these variable morphotypic gradations, perhaps subject to the influences of sex expression, and a range of hormonal activity at times associated with reiteration phenomena, cannot be adequately used to characterize the taxa at a supraspecific level. Likewise, stigmatic and stylar characters have also been shown to vary in similar fashion, (Pipoly 1991a, 1992b) with one notable exception. To date, no ligulate stigmas have been found in neotropical taxa, although some taxa have been described with short styles (Pipoly 1992b). Therefore, I see no reason to recognize *Rapanea* as a distinct entity from *Myrsine*, even though some nomenclatural adjustments will have to be made to accomplish its total synonymy. In phylogenetic terms as well, it is more parsimonious to assume that the small, umbellate or fasciculate inflorescence structure, concomitant with the acropetally accumulating floral bracts along the perennating peduncle forming the "short shoot," would have arisen only once. However, owing to the sheer size of the group and dearth of knowledge about its taxa in many of its most species-rich geographic areas, a full phylogenetic analysis must await the accumulation of further data from the taxa on a comprehensive, worldwide scale.

NOTES ON MORPHOLOGICAL TERMINOLOGY AND SPECIMEN CITATION

Morphological terminology follows Pipoly (1987, 1991a, 1992b, 1992c) and Chen and Pipoly (in press). Specimens are cited according to island, north to south (e.g., Luzon, Mindoro, Panay, Palawan, Mindanao), then alphabetically by province within each island. Traditional divisions into regions, such as that used by Merrill (1923) is problematic, and is not used here, because some islands have since been reassigned from one region to another. When known, the collector, his personal collection number, followed by the herbarium number, is cited. In some cases, such as that of the Ramos and Edaño collections, specimens deposited at A, BISH, GH, K, L, NY, PNH, or US may have only the collector's personal number, only the BS (Philippine Bureau of Science), the FB (Forestry Bureau) or the PNH (Philippine National Herbarium) number, or may have the personal and one of the institutional numbers. The institutional numbering has resulted in much confusion for the curator desiring to update determinations. In order to remedy this, I include both number types whenever I have been able to match them.

TAXONOMIC TREATMENT

Myrsine L., Sp. Pl. 1:196. 1753, Gen. Pl. ed 5:90. 1754; R. Brown, Prodr. 1:533. 1810; Roemer & Schultes, Syst. Veg. 503. 1819; Sprengel, Syst. Veg. 1:664. 1825. A. DC., Trans. Linn. Soc., London, Bot. 17:104. 1834, Ann. Sci. Nat., Ser. 2, 9:292. 1834, Ann. Sc. Nat., Ser. 2, 16:65–97, 129–196, t. 1–3, 8–9, 1841; A. DC in DC, Prodr. 8:92. 1844; Miquel in Martius, Fl. Bras. 10:306. 1856, Fl. Ned. Ind. 2:1014. 1856. Scheffer, Myrs. Arch. Ind. 46. 1867. Hooker in Bentham & Hooker, Gen Pl. 2:642. 1876. Clarke in Hook. f. Fl. Brit. India 3:511. 1882., Pax in Engler & Prantl, Pflanzenfam. IV. 1:92. 1889; Koorders & Valeton, Bijdr. Boomsoort. Java 5:228. 1900; Mez in Engler, Pflanzenr. 9(IV. 236):338. 1902; Walker, Philipp. J. Sci. 73:1940, Bot. Mag. Tokyo 67:249. 1954, Bull. Agri. Home Ec. Univ. Ryuku 2:76. 1955, Quart. J. Taiwan Mus. 12:164. 1959; F. Meyer & E. Walker, Fl. Japan 713. 1965; Stearn, Bull. Brit. Mus. (Nat. Hist.), Bot. 4:174. 1969; Fosberg & Sachet, Smithsonian Contr. Bot. 21:3–11. 1975; H-L. Li, Fl. Taiwan 48. 1978; Lundell, Phytologia 48:137. 1981, Phytologia 56:418. 1984; Halliday, Fl. Tr. E. Afr. Myrs. 6. 1984; A. Nicholson in D. Nicholson, Fl. Domin. 2:160. 1991; Pipoly, Novon 1:204. 1991, Caldasia 17:1. 1992, Novon 2:392. 1992; Guzmán-Teare, Cat. Fl. Pl. & Gymno. Peru 732. 1993; Pipoly & Chen, Novon 5:360. 1995; Harvey & Pipoly, Fl. Pico das Almas 487. 1995; Chen & Pipoly, Fl. China 15:34–38. (In press). TYPE SPECIES (by monotypy): *Myrsine africana* L.

Rapanea Aublet, Hist. Pl. Guiane I:121. t. 46. 1775; A. Jussieu, Gen. Pl. 288. 1789. Miquel in Martius, Fl. Bras. 10:306. 1856; Mez in Urban, Symb. Antill. 2:427. 1901; Mez in Engler, Pflanzenr. 9(IV. 236):342. 1902; Pitard, in LeComte, Fl. Gen. Indoch. 3(6):786. 1930; Standley, Publ. Field Mus. Nat. Hist., Bot. Ser 18(2):898. 1938; Bâthie, Fl. Madagascar 161:138. 1953; Lundell, Fieldiana, Bot. 24(8–1):190. 1966, Fl. Panama 8:286. 1971; Fournet, Fl. Ilus. Phan. Guadeloupe et Martinique 1046. 1978; Taton, Fl. Afr. Cent. Myrs. 53. 1980; Kupicha, Fl. Zambesiaca 7:201.

1983; Halliday, Fl. Trop. E. Afr. Myrs. 2, 8. 1984; Little et al., Arbol. Puerto Rico y Islas Virg. 2:872. 1988.

Samara Swartz, Prodr. 1:261. 1788, *non* Linnaeus, Mant. 144, 199. 1771.

Manglilla A. Jussieu, Gen. Pl. 151. 1789.

Athruphyllum Loureiro, Fl. Cochinch. 1:148. 1790.

Caballeria Ruíz et Pavón, Fl. Peruv. Prodr. 141. t. 30, 1794.

Suttonia A. Richard, in Dumont d'Urville, Déc. Astrolabe Bot. 1:349. 1832, *et* Ess. Fl. Nouv.-Zel. 349. pl. 38. 1832; Lévillé, Repert. Spec. Nov. Regni Veg. 10:443. 1912; Rock, Indig. Tree Hawaiian Is. 367–380. 1974.

Shrubs or small trees. Leaves alternate, exstipulate. Inflorescences lateral (axillary), umbellate or fasciculate, sessile or on short, perennating peduncles girdled by persistent floral bracts (thus forming “short shoots”). Flowers 4–5(–6)-merous, bisexual or unisexual (plants then monoecious, dioecious, or polygamous); sepals nearly free or united to 1/2 length, imbricate or valvate, usually ciliate, punctate, persistent; petals nearly free or rarely united to 1/2 their length, usually ciliate, glandular-granulose at least along margin and often throughout within, punctate; stamens and staminodes similar, subequalling corolla length, the filaments free or connate basally to form a tube, the tube with or without sterile appendages alternating with the filaments, and all merely adnate to the corolla tube; or developmentally fused throughout, the anthers thus appearing epipetalous, the anthers ovate or reniform, rarely sagittate, 2-celled, dehiscing by longitudinal slits, rarely by subterminal pores opening later into wide longitudinal slits. Pistil and pistillode similar; obconic, obturbinate, obnapiform, or variously subglobose; ovary globose, costate or not, glabrous or glabrescent; ovules few, uniseriate, or rarely biseriate, completely immersed in placenta or seated below apical pores in placenta or variously projecting; style obsolete to present, tapering into stigma; stigma morchelliform, liguliform, sinuate to lobate, prismatic and 3-lobed, or rarely, conical. Fruit a globose, subglobose, ellipsoid, ovoid, or subovoid drupe, with somewhat fleshy exocarp and crusty or leathery endocarp, 1-seeded. Seed occupying cavity; endosperm horny, ruminant; embryo cylindric, transverse.

Myrsine, as here defined, contains ca. 300 species, of which nearly 1/4 remain undescribed, distributed pantropically. They occupy habitats from mangroves to subalpine scrub, but always in moist, wet or pluvial habitats. In the Philippines, 14 species are known, separable by the following key.

KEY TO MYRSINE OF THE PHILIPPINES

1. Flowers borne in sessile to subsessile umbels, the peduncle apparently not perennating, obsolete to 3.5 mm long.
2. Leaf blades 1.5–1.8(–1.9) cm wide.
3. Young branchlets and petioles rufous-puberulent or glandular-papillose; leaf blades dull to subnitid above, the midrib impressed above, prominently raised below, the punctations pellucid, inconspicuous.

4. Leaf blades linear to narrowly oblanceolate; petioles marginate, not canaliculate; pedicels obconic, (1.5–)2–2.5(–3) mm long; young branchlets and petioles rufous puberulent and glandular-granulose. 1. *M. medeciloae*
4. Leaf blades elliptic to lanceolate; petioles deeply canaliculate, not marginate; pedicels cylindric, 5–7 mm long; young branchlets and petioles rufous glandular-papillose, not puberulent or glandular-granulose. 2. *M. apoensis*
3. Young branchlets and petioles glabrous; leaf blades nitid to laccate above, the midrib prominently raised above and below, the punctations numerous, prominently raised.
 5. Leaf blades symmetric, oblong or elliptic, the apex obtuse to rounded, prominently retuse to emarginate at tip, the margins revolute; fruit globose. 3. *M. amorosoana*
 5. Leaf blades asymmetric, narrowly oblong to narrowly oblanceolate, the acuminate but bluntly rounded at tip, the margins flat; fruit oblongoid. 4. *M. oblongibacca*
2. Leaf blades > (1.8–)2 cm wide.
 6. Branchlets angulate; fruit depressed-globose, subglobose, or ovoid.
 7. Leaf blade cartilaginous, laccate above, smooth above and below, the apex rounded to obtuse, the tip retuse to emarginate; pedicels straight, not reflexed in anthesis; fruit 5–6 mm diam. 5. *M. cruciata*
 7. Leaf blade coriaceous, dull or somewhat nitid above, sparsely to densely scrobiculate above and below, the apex short-acuminate to acutish or obtuse, not emarginate or retuse at tip; pedicels reflexed in anthesis; fruit 2.2–5 mm diam.
 8. Leaf blade symmetric, apically acutish to obtuse; pedicels cylindric, 1.5–2.5 mm long. 6. *M. densiflora*
 8. Leaf blade asymmetric, apically short-acuminate; pedicels obconic, 3–5 mm long. 7. *M. peregrina*
 6. Branchlets terete; fruit globose.
 9. Leaf blade chartaceous, inconspicuously punctate above, the base acute to cuneate, decurrent to base of petiole; petiole 6–8 mm long; branchlets minutely rufous papillose and early glabrescent, or glabrous at first.
 10. Leaf blade scrobiculate above; branchlet apex minutely rufous papillose at first; calyx 0.8–1 mm long; plants of submontane forests. 8. *M. mindanaensis*
 10. Leaf blade smooth above; branchlet apex glabrous; calyx 1.0–1.5 mm long; plants of mangrove swamps. 9. *M. philippinensis*
 9. Leaf blade coriaceous, prominently pellucid punctate above, the base obtuse to rounded, not decurrent on petiole to base; petiole 10–15 mm long; branchlets densely rufous tomentose at first. 10. *M. arenis*
 1. Flowers borne in fascicles or umbels, on perennating peduncle-like short shoots usually greater than 3.5 mm long at maturity.
 11. Flowers in fascicles; pedicels obsolete to 2.5 mm long; leaf blades sparsely and conspicuously, but not prominently punctate above.
 12. Floral bract margins erose-fimbriate, long white glandular-ciliolate; peduncles (3.5–)4–12.5 mm long; corolla lobes densely and prominently red-punctate along entire margin, densely and prominently

- pellucid punctate-lineate medially; anther connective red punctate lineate; leaf margin flat. 11. *M. penibukana*
12. Floral bract margins entire, rufous glandular-ciliolate; peduncles 3.5–4 mm long; corolla lobes densely and prominently black punctate medially, epunctate marginally; anther connective punctate; leaf margin revolute. 12. *M. fastigiata*
11. Flowers in umbels; pedicels 2.6–6 mm long; leaf blades densely and conspicuously or prominently punctate above.
13. Branchlets 7–10 mm diam., drying sulcate; leaf blades thickly coriaceous to cartilaginous; densely but not prominently pellucid or red punctate; leaf buds covered by minute translucent or rubiginous glandular scales; petioles marginate and canaliculate, 5–10 mm long; without raised midrib; peduncle stout, (3–)3.5–4 mm diam.; pedicels 2.6–4 mm long; sepals deltate, 1.5–2 mm long. 13. *M. aralioides*
13. Branchlets 3–3.5 mm diam., longitudinally ridged, but not sulcate; leaf blades coriaceous, densely and prominently pellucid punctate above and below; leaf buds densely appressed rufous glandular-stellate and -dendroid tomentose; petioles short-marginate, 3–5 mm long, not canaliculate, the midrib raised to petiole base; peduncle thin, 1–2 mm diam.; pedicels 4–6 mm long; sepals widely ovate, 0.6–0.9 mm long. 14. *M. glandulosa*

1. *Myrsine medeciloae* Pipoly, nom. nov. (Fig. 1A, B). *Rapanea angustifolia* Merrill, Philipp. J. Sci. 20:429. 1922, *non Myrsine angustifolia* (A. DC.) D. Dietr., Synops. 1:619. 1839 [*Embelia angustifolia* A. DC.], *nec Myrsine angustifolia* E. Meyer ex Schimper, Traité Pal. Végét. 2:922. 1872 (nom. nud.), *nec Myrsine angustifolia* Heller, Minn. Bot. Stud. Bull. 9:873. 1897, *nec Myrsine angustifolia* (Mez) Hosaka, Occ. Pap. Bish. Mus. 16:42. 1940 [*Suttonia angustifolia* Mez, Pflanzenr. 9 (IV. 236):337. 1902.] TYPE: PHILIPPINES. LUZON ISLAND. Ilocos Norte Prov.: Mt. Nagappatan, Aug 1918 (fr), M. Ramos BS 33243 (HOLOTYPE: PNH-destroyed; LECTOTYPE, here designated: A!).

Shrub or small tree, height unknown. *Branchlets*: essentially terete, 1.5–2 mm diam., densely rufous-puberulent and glandular-granulose apically, glabrescent. *Leaves*: buds densely rufous-puberulent and glandular-granulose, rufous glandular-ciliate along margins; blades chartaceous, symmetric, linear to narrowly linear-oblongate, (2.5–)5–6.5 cm long, 0.6–1.0(–1.5) cm wide, obtuse apically, retuse at apex tip, acute basally, decurrent to petiole base, smooth and nitid above, pallid below, densely and prominently black punctate below toward apex, the midrib impressed above, prominently raised below, secondary veins 12–15, slightly prominulous above and below, the marginal collecting vein ca. 0.5 mm from margin, entire and revolute; petioles marginate, not canaliculate, 4–9 mm long, rufous puberulent at first, glabrescent. *Staminate inflorescence*: sessile, 6–12-flowered; floral bracts coriaceous, lanceolate, 1 mm long, 0.3 mm wide, apically acute, densely and prominently black punctate medially, the margin entire, densely glandular-ciliolate; pedicels cylindric, 1.5–3 mm long. *Staminate flowers*: 4-merous, chartaceous, 2.5–3 mm long; calyx cotyliform, 0.7–0.9 mm long,



FIG. 1. A-B. *Myrsine medecilloae* Pipoly. A. pistillate branch, note sessile umbels (lectotype). B. Staminate branch (R. Meyer BS 3114). C. *Myrsine oblongibacca* (Merrill) Pipoly, showing oblongoid fruit (lectotype). D. *Myrsine apoensis* (Elmer) Pipoly, pistillate branch, showing few-flowered inflorescences and elliptic leaves (lectotype). E-G. *Myrsine amorosoana* Pipoly. E. Pistillate branch, showing revolute leaf margins and globose fruits (G. Edaña 76198). F. Staminate branch, showing retuse leaf apices (G. Argent & E. Reynoso 89112). G. Pistillate branch, showing fewer-fruited inflorescences and much larger leaves (G. Edaña BS 76198). H-I. *Myrsine cruciata* (Philipson) Pipoly. H. Staminate branch (J. & M. Clemens 30258). I. Pistillate branch, showing ovoid fruits (C. Ridsdale SMHI 225). Black scale bar equals 1 cm, smallest unit on white scales equals 1 mm.

the tube 0.1–0.2 mm long, the lobes deltate to ovate, 0.5–0.8 mm long, 0.5–0.7 mm wide, acute apically, prominently black punctate medially, along the margins opaque, irregular and apically somewhat erose, sparsely glandular-ciliolate; corolla rotate, 1.8–2.2 mm long, the tube ca. 0.5 mm long, the lobes oblong, 1.3–1.7 mm long, 0.5 mm wide, rounded apically, densely and prominently black punctate without except at margin, densely glandular-granulose on the margin and apically within, entire along margin; stamens 1.4–1.6 mm long, the filaments developmentally fused to corolla tube, the anthers apparently epipetalous, sessile, widely ovate, 1–1.2 mm long, 1–1.3 mm wide, apically obtuse, basally subcordate, densely and prominently black punctate abaxially; pistillode hollow, conic, ca. 0.5 mm long, the stigmatic area somewhat lobed. *Pistillate inflorescence*: sessile, 3–6-flowered; floral bracts coriaceous, ovate, ca. 1 mm long, 0.8–1 mm wide, acute apically, densely and prominently black punctate medially, entire and densely glandular-ciliolate along margin; peduncle obsolete; pedicels obconic, (1.5–)2–2.5(–3) mm long. *Pistillate flowers*: like staminate but 2.3–3.0 mm long; calyx cotyliform, 0.7–1 mm long, the tube ca. 0.2 mm long, lobes deltate, 0.5–0.8 mm long and wide, apically acute to subacuminate; corolla subrotate, 1.6–1.9 mm long, the tube ca. 0.5 mm long, the lobes oblong, 1.1–1.4 mm long, 0.5 mm wide; staminodes resembling stamens but filaments obsolete, the antherodes widely ovate, 1–1.2 mm long, 1–1.3 mm wide, apically obtuse, basally subcordate, densely and prominently black punctate abaxially, devoid of pollen; pistil conic, 1.3–1.5 mm long, the ovary 0.7–0.9 mm long, 1–1.2 mm diam, the stigma 3–5 mm long, 4-lobed, the lobes ligulate with variously lacerate margins; ovules 3–4, completely buried in the placenta. *Fruit* globose, 3–4 mm long and diam., densely and prominently black punctate with minute punctations in the upper 1/3 of fruit, the persistent stigma 3–4-lobed.

Distribution.—Endemic to western Luzon Island, in Ilocos, Bataan and Zambales provinces, Philippines, at 1,000–1,800 m elevation.

Ecology and conservation status.—*Myrsine medeciloae* is a rare species, occurring only in submontane mossy forests in the northern portion of the country. Because of habitat destruction, this species is considered endangered and most populations may be extinct.

Etymology.—It gives me great pleasure to dedicate this species to Melanie Medecilo, Philippine Administrator for the Philippine Plant Inventory Project. Ms. Medecilo is a budding systematic botanist with strong organizational skills, infinite patience, and much creativity.

Common name.—"Aribangib" (Negrito language, Madulid 1992).

Specimens examined: **PHILIPPINES. LUZON ISLAND. Bataan Prov.**: Mt. Mariveles, Lamao River, May 1905 (stam. fl), *R. Meyer* BS 3114 (NY, US). **Ilocos Norte Prov.**: Burgos, Jul 1918 (fr), *M. Ramos* BS 32757 (A); en route from miner's camp to Mt. Burnay

in Mt. Sicapoa Range, 1,700–1,800 m, 3 Dec 1975 (pist. fl, fr), *K. Iwatsuki et al.* 719 (L-2 sheets.). **Zambales Prov.:** Mt. Lapulao, Nov–Dec 1907 (fr), *H. M. Curran & M. L. Merritt* BS 8072 (US).

Myrsine medeciloae is closely related to *M. apoensis*, but can easily be distinguished by its linear or narrowly oblanceolate leaves, short, cylindric pedicels, and young branchlets and petioles rufous puberulent and glandular-granulose.

2. *Myrsine apoensis* (Elmer) Pipoly, comb. nov. (Fig. 1D). *Rapanea apoensis* Elmer, *Leaflet Philipp. Bot.* 2:669. 1910. TYPE: PHILIPPINES. MINDANAO ISLAND. North Cotabato Prov.: Mt. Apo, Todaya, May 1909 (pist. fl, fr), *A. Elmer* 10629 (HOLOTYPE: PNH-destroyed; LECTOTYPE, here designated: A!; ISOLECTOTYPES: BISH!, GH-2 sheets!, K!, L!, NY!).

Tree to 4 m tall. *Branchlets:* terete, 1.5–2.5 mm diam., densely rufous glandular-papillose, glabrescent. *Leaves:* buds densely rufous glandular-papillose, margins densely translucent-ciliate along margins, glabrescent; blades membranaceous to chartaceous, symmetric, elliptic to lanceolate, 1.7–6.5 cm long, 0.8–1.8 cm wide, apically acuminate to an obtuse tip, basally acute, narrowly decurrent about $\frac{3}{4}$ along the petiole toward base, smooth, subnitid and inconspicuously pellucid punctate above, inconspicuously pellucid punctate below, midrib immersed above, prominently raised below, the secondary veins 9–13 pairs, barely prominulous above and below, the submarginal collecting vein ca. 0.25 mm from margin, entire and revolute along margin; petioles deeply canaliculate, not marginate, 4–9 mm long, densely rufous glandular-papillose above, glabrescent. *Staminate inflorescence:* unknown. *Pistillate inflorescence:* a subsessile to sessile umbel, 3–6-flowered; peduncle rarely to 1 mm long, ca. 0.5 mm diam.; floral bracts chartaceous, oblong, 1.8–2.2 mm long, 1.3–1.5 mm wide, apically broadly rounded, prominently black punctate-lineate medially, slightly erose and sparsely glandular-ciliate along the margin; pedicels cylindric, 3–6 mm long. *Pistillate flowers:* 5-merous, chartaceous, 2–2.5 mm long; calyx cotyliform, 0.8–1 mm long, the tube ca. 0.2 mm long, the lobes suborbicular, 0.6–0.8 mm long and wide, apically acute, medially carinate at first, then flattening with age, densely red punctate and punctate-lineate, with a hyaline, irregular, entire, rufous glandular-ciliolate margin; corolla rotate, 2–2.5 mm long, the tube ca. 0.2–0.4 mm long, the lobes lanceolate, 1.8–2.1 mm long, 0.2–0.4 mm wide, apically acute, densely and prominently red punctate-lineate medially, densely glandular-granulose toward apex within and along the margins, with margins densely glandular-granulose, entire; staminodes 1.2–1.4 mm long, the filaments 0.2–0.4 mm long, completely fused to corolla tube, the antherodes ovate, 0.9–1.1 mm long, 0.3–0.4 mm wide, apically rounded, basally cordate, devoid of pollen, the connective darkened dorsally; pistil obnapiform, the ovary 1.5 mm

long and diam., the style short, ca. 0.5 mm long, truncate terminally, the style ligulate, alate, the wings 4; ovules 3–5, partially immersed in the placenta. *Fruit* subglobose, slightly longer than wide, 2.6–3.5 mm long, 2.3–3 mm wide, prominently red punctate-lineate.

Distribution.—Endemic to Mindanao Island, on Mts. Apo and McKinley, North Cotabato, Davao and Davao del Sur provinces, at 1,666–2,900 m elevation.

Ecology and conservation status.—*Myrsine apoensis* is restricted to the mossy forests occurring on the upper slopes and summits of the mountains it is known from. These forests are not commercially exploited, but are subject to destruction due to activities related to construction and maintenance of telecommunication towers. Therefore, the species should be considered highly endangered.

Etymology.—The specific epithet refers to the type locality, Mt. Apo, located at the junction of North Cotabato, Davao and Davao del Sur provinces.

Common names.—"Karyos" (Bagobo language, Merrill 1926); "Marintok" (Bagobo, Madulid 1992), "Tongog" (Bagobo language, Bisayan, Panay dialect, Madulid 1992).

Specimens examined. **PHILIPPINES. MINDANAO ISLAND. Davao del Sur Prov.**: Mt. Apo, [Todaya], N slope, Lake Linao, 2,100 m, 30 Oct 1946 (fr), *G. Edaño* 1266 (PNH 1382), 1 Nov 1946 (fr), *G. Edaño* 1267 (PNH 1383) (A, PNH), 20 May 1974 (fr), *Univ. San Carlos* 586 (L); Mt. McKinley, summit, 2,466 m, 13 Sep 1946 (fr), *G. Edaño* 984 (PNH 1048) (A, L, PNH); 1,666 m 28 Aug 1946 (ster.), *G. Edaño* 821 (PNH 1032) (L, PNH). **North Cotabato Prov.**: Kidapawan Municipality, Mt. Apo Geothermal Project Site G, 06°59.5'N, 125°14'E, 1,820 m, 8 Nov 1992 (fr), *L. Co* 3649 (A, CANB, CAHUP, K, L, PNH, PUH, TI, US).

Myrsine apoensis appears to be closely related to *M. medecilloae*, but is readily distinguished by the elliptic to oblanceolate leaf blades, canaliculate petioles, the longer, cylindric pedicels and the rufous glandular-papillose (not puberulent or granulose) young branchlets and petioles.

3. *Myrsine amorosoana* Pipoly, nom. nov. (Fig. 1E–G). *Rapanea retusa* Merrill, Philipp. J. Sci. 2:297. 1907. TYPE: PHILIPPINES. MINDORO ISLAND. Oriental Mindoro Prov.: Mt. Halcon, Nov 1906 (fr), *E. Merrill* 5734 (HOLOTYPE: PNH-destroyed; LECTOTYPE, here designated: US!; ISOLECTOTYPES: K!, NY!), *non Myrsine retusa* Aiton, Hort. Kew 1:271. 1789. *nec Myrsine africana* var. *retusa* (Aiton) A. DC., Trans. Linn. Soc., Bot. 17:105. 1834.

Shrub or small tree to 3(–5) m tall. *Branchlets*: terete, 2.5–3 mm diam. glabrous. *Leaves*: buds glabrous with margins sparingly rufous glandular-ciliate; blades thinly coriaceous, symmetric, oblong or elliptic, (2.3–) 3–5(–6) cm long, (0.8–) 1.5–1.9 cm wide, apically retuse to emarginate at tip, basally cuneate, smooth and nitid to laccate above, densely and prominently black punctate below, midrib prominently raised above and below,

the secondary veins 6–10 pairs, not visible above, more or less prominulous below, the submarginal connecting vein ca. 1 mm from margin, entire and revolute along the margin; petiole marginate, 4–9(–12) mm long, with a decurrent midrib prominently raised adaxially to base, glabrous. *Staminate inflorescence*: subsessile, 3–9-flowered; peduncle 1.5–2 mm long, 0.5–1 mm diam.; floral bracts coriaceous, deltate, ca. 0.5 mm long and wide, apically acute, inconspicuously punctate, irregular to erose and glandular ciliate along the margin; pedicels cylindrical, 2–3 mm long. *Staminate flowers*: 4-merous, coriaceous, 1.5–1.8 mm long; calyx cupuliform, 1–1.2 mm long, the tube 0.3–0.5 mm long, the lobes oblate, 0.5–0.7 mm long, 0.6–0.8 mm wide, apically obtuse to subacute, medially prominently red punctate, irregular, erose, and sparingly glandular ciliate along the margin; corolla rotate, 1.6–1.8 mm long, white, the tube ca. 0.2 mm long, the lobes elliptic, 1.4–1.6 mm long, 0.7–1 mm wide, apically obtuse, densely and prominently red punctate and punctate-lineate toward apex and along margins without, densely glandular-granulose outside and along margin within; stamens 1–1.2 mm long, the filaments fused to the corolla tube 0.2 mm, the anthers widely ovate, 0.8–1 mm long, 0.6–0.8 mm wide, apically acute, basally slightly cordate, opening by large subapical introrse pores, then large longitudinal slits, the connective inconspicuously brown-punctate dorsally at apex; pistillode ellipsoid, 0.7 mm long, the ovary 0.3–0.5 mm long, 0.2–0.3 mm diam., the stigma translucent, amorphous, 0.2 mm long. *Pistillate flowers*: like staminate but 1.6–1.9 mm long; calyx 1–1.2 mm long, the tube ca. 0.1 mm long, the lobes 0.9–1.1 mm long, 0.6–0.8 mm wide; corolla 1.6–1.9 mm long, the tube 0.2–0.3 mm long, the lobes 1.4–1.6 mm long, 0.2–0.3 mm wide; staminodes 0.8–1 mm long, the filament completely fused to the corolla tube in development, 0.3 mm long, the antherodes sublinear to ovate, 0.5–0.7 mm long, 0.1–0.2 mm wide, apically acute, the base not distinguishable; pistil globose, 1.3–1.5 mm long, the placenta globose, the ovules 4–6, in 2 series, the stigma 4-lobed, arrow-head-like, the lobes fin-shaped, ca. 0.5 mm long, 0.7 mm wide. *Fruit* globose, 2–3 mm long and in diam., violet at maturity, densely and prominently red punctate.

Distribution.—Endemic to the Philippines, from north central Luzon Island southward through Mindoro, Sibuyan and Negros Islands to northern Mindanao, at 1,400–2,825 m elevation. The collection from Bicol National Park (B. Hernaez & M. Cajano CAHUP 572, 57283, 57284) was undoubtedly from near the 1,900 m elevation and not the lower extreme indicated on the label.

Ecology and conservation status.—Frequent in mossy forest, “Ramayan” forest, dominated by gymnosperms and *Tristaniopsis* (Myrtaceae) and upper

montane moist forest, particularly on ultramafic substrates. *Myrsine amorosoana* forms large patches of individuals along ridgetops in forests dominated by *Phyllocladus hypophyllus* (Podocarpaceae), with an understory dominated by *Polyosma verticillata* (Escallionaceae). It occurs with a density of approximately 50 individuals per hectare, a figure perhaps exceeded only by *Myrsine dependens* (Ruíz & Pavón) Sprengel f., of the northern Andes of South America, and *M. pittieri* (Mez) Lundell of Costa Rica and Panama. It may be that some of the species currently under *Rapanea* and undergoing revision for the entire island of New Guinea, may have even more extensive populations. *Myrsine amorosoana*, by virtue of its large, but extremely localized populations, should be considered threatened.

Etymology.—This species is dedicated to my friend and colleague, Dr. Victor Amoroso, professor of biology and curator of the herbarium of Central Mindanao University, in Musuan, Bukidnon Province, Mindanao. Dr. Amoroso is an authority on the systematics of Philippine pteridophytes, a prodigious fieldworker and an enthusiastically supportive colleague. His indefatigable efforts in conservation and monitoring of the biodiversity of Mindanao's forests are exemplary.

Common names.—"Biribenlog" (Bikol language, *Ramos & Edaño BS 26577*); "Maromo" (Negrito, Madulid 1992).

Specimens examined. **PHILIPPINES. LUZON ISLAND.** *sine loc. esp.* 1792 (fr), *T. Haenke* 440, 447, 472, (NY). **Benguet Prov.:** Kabayan, Mt. Pulog National Park, 10 Aug 1992 (fr), *E. Barbon et al. PPI 8845* (A, BO, BRIT, K, L, PNH, US); Mt. Pulog, Feb–Mar 1925 (fr), *M. Ramos & G. Edaño BS 44936* (US). **Camarines Norte Prov.:** Dec 1913 (fr), *M. Ramos BS 1524* (A, L, NY), (stam. fl), *M. Ramos BS 1525* (A, L, NY). **Camarines Sur Prov.:** Mt. Isarog, "Dec 1928"[probably Nov] (fr), *G. Edaño BS 76198* (A, K, NY, PNH), 1,370 m, 28 Nov 1928 ["Dec 1928"on lower label] *G. Edaño 630 {BS 76225}* (A, NY); *BS 76268* (NY); Mt. Isarog, Naga City, 6 Apr 1992 (fr), *Barbon et al. PPI 8223* (A, BO, BRIT, K, L, PNH); Mt. Isarog, Nov–Dec 1913 (fr), *M. Ramos 22009* (NY, US); Bicol National Park, Ocampo del Rosario, S access trail W of PLDT, 670–1,900 m, 22–27 Oct 1991 (fr), *B. Hernaez & M. Cajano CAHUP 57282, 57283, 57284* (CAHUP). **Mountain Prov.:** Mt. Pulog, 16°36'N, 120°54'E, 2,550–2,650 m, 30 Jan 1968 (fr) *M. Jacobs 7227* (A, K, L, LBC, PNH); 2,600–2,700 m, 1 Feb 1968 (fr), *M. Jacobs 7274* (A, K, L, LBC PNH); 2,300–2,500 m, 5 Feb 1968 (stam. fl), *M. Jacobs 7333* (A, K, L, PNH), 2,300–2,400 m, 17 Feb 1968 (fr), *M. Jacobs 7488* (L, PNH); Lake Pulog, Aug 1915 (pist. fl), *M. Ramos BS 23616* (A, K, PNH, US), 24–25 Oct 1965 (fr), *R. Robbins s.n.* (L). **Nueva Vizcaya Prov.:** Mt. Alzapan, May–Jun 1925 (fr), *M. Ramos & G. Edaño BS 45602* (NY). **Quezon [Tabayas] Prov.:** Mt. Binuang, May 1917 (fr), *M. Ramos & G. Edaño BS 28758* (A, K, PNH, US); Mt. Dingalan, Aug–Sep 1916 (stam. fl), *M. Ramos & G. Edaño BS 26577* (A, US); Mt. Mirador, summit, Antimonan Municipality, 13 Sep 1975 (fr), *B. Hernaez 3043* (CAHUP), Quezon National Forest Park, Atimonan summit, 400 m, 26 Aug 1984 (fr), *I. Lit IL84 001 {CAHUP 40296}* (CAHUP). **Sorsogon Prov.:** Jul–Aug 1915 (stam. fl), *M. Ramos BS 23512* (BISH, K, PNH, US). **MINDORO ISLAND. Prov. Oriental Mindoro:** Mt. Halcon, near Paitan, Dulangan River, 13°12'N, 121°12'E, 1,200 m (fr), *C. Ridsdale et al. 1703* (A, K, L, LBC, PNH); NE summit, 2,000–2,580 m, Apr–May 1995 (pist. fl), *E.*

Mandia 421 (CAHUP, DLSU); N coast, Mindoro, Subaan River headwaters, inland from San Teodoro, 1,200 m, 30 Apr 1986 (fr), *M. Coode et al.* 5635 (A, K, L, LBC, PNH); Mt. Halcon, 15–24 Jun 1906 (fl), *M. Merritt* BS 4449 (US), Nov 1906 (fr), *E. Merrill* 5735 (L); NE Mindoro, Mustning, Mt. Halcon Complex, above Paitan on Dulangan River, 1,450–1,500 m, 11 May 1986 (fr), *M. Coode et al.* 5765 (A, K, L, PNH). Rizal, Augilog Mar 1906 (fr), *A. Lohr* 6128 (K); *sine loc. esp.*, Nov 1914 (fr), *M. Ramos* BS 1961 (L, NY). **SIBUYAN ISLAND. Prov. Romblon:** Mt. Guiting-guiting, Camp 3 above Magdiwang on ridge leading to Mayos' Peak, 1,400 m, 27 Aug 1989 (stam. fl), *G. Argent & E. Reynoso* 89112, (fr), 89113 (E, K, PNH); Magdiwang, Mt. Guiting-guiting, Mayos Peak, 12°28'N, 122°32'E, 5 Jun 1992 (fr), *B. Stone et al.* PPI 6906 (A, BO, BRIT, K, L, PNH, US). **NEGROS ISLAND. Negros Occidental Prov.:** Mt. Canlaon Volcano, 1950 m, 10 Apr 1954 (fr), *G. Edaño* PNH 21960, 8195 {PNH 22003} (A, K, L, PNH). **MINDANAO ISLAND. Bukidnon Prov.:** Mt. Candoon, Jun–Jul 1920 (fr), *M. Ramos & G. Edaño* BS 38918 (A); Mt. Lipa, Jun–Jul 1920 (fr), *M. Ramos & G. Edaño* BS 38528 (A, L); Lantapan Municipality, Sitio Sungco, Mt. Kinasalapi, part of Kitanglad Mt. Range, W of Alanib River, SW slopes, ca. 08°00'05"N, 124°30'26" E; 2,090–2,360 m, 4 Dec 1984 (ster), *J. Pipoly et al.* PPI 16610, (BRIT, PNH) (fr) *Pipoly et al.* PPI 16647. (BRIT, PNH) (fr), *J. Pipoly et al.* PPI 16684 (BRIT, PNH), 6 Dec 1994 (fr), *Pipoly et al.* PPI 16871 2,200–2,320 m, 14 Apr 1995 (fr), *J. Pipoly et al.* 19551 {PPI 19796} (BRIT, PNH), (fr), 19555 {PPI 19800} (BRIT, PNH); Mt. Dulangdulang, Mt. Kitanglad Range, 20 km SE of Dalwangan, Malaybalay Municipality, 87°5'N, 124°56' E, 2,385–2,825 m, 25–30 May 1993 (fr), *B. Hernaez & M. Cajano* 2380 {CAHUP 60561, 60562, 60563, 60564} (CAHUP).

Myrsine amorosoana is most closely related to *M. oblongibacca*, but is separated by the symmetric, oblong to elliptic leaf blades with obtuse to rounded apices and revolute margins, and the globose fruits.

4. *Myrsine oblongibacca* (Merrill) Pipoly, comb. nov. (Fig. 1C). *Rapanea oblongibacca* Merrill, Philipp. J. Sci. 20:429. 1922. TYPE: PHILIPPINES. LUZON ISLAND. Ilocos Norte Prov.: Mt. Palimlim, Aug 1918 (fr), *M. Ramos* BS 33256 (HOLOTYPE: PNH-destroyed; LECTOTYPE, here designated: A!; ISOLECTOTYPE: K!).

Glabrous shrub to 3 m tall. *Branchlets*: somewhat angulate at very tip, soon terete, 2–3 mm diam. *Leaves*: buds glabrous with margins sparsely glandular ciliolate; blade chartaceous to subcoriaceous, asymmetric, narrowly oblong to narrowly oblanceolate, 3–6(–7.4) cm long, 0.8–1.8 cm wide, apically subacuminate to obtuse, but blunt at tip, basally cuneate, decurrent on the petiole, smooth, prominently pellucid punctate and nitid above, prominently pellucid punctate and black punctate-lineate below, midrib prominently raised above and below, the secondary veins 7–12 pairs, not visible above, inconspicuous below, the submarginal collecting vein ca. 0.5 mm from margin, densely and prominently black punctate below, entire, and flat along margin; petioles canaliculate and marginate, 3–8 mm long, glabrous. *Staminate inflorescence*: unknown. *Pistillate inflorescence*: subsessile, or on an apparently annual, peduncle 1.5–2 mm long, up to 1 mm diam.; floral bracts chartaceous, linear, 0.5–0.7 mm long, 0.1–0.2 mm wide, apically acute, densely black punctate, entire and glabrous along the margin; pedicels cylindric, 2–3 mm long, sparsely black punctate-lineate.

Pistillate flowers: unknown; fruiting calyx 4–5-merous, cotyliform, 1–1.2 mm long, the tube ca. 0.2 mm long, the lobes irregular, ovate, 0.8–1 mm long, 0.5–0.7 mm wide, apically acute to acuminate, densely and prominently black punctate medially, densely glandular-ciliate along the margin. *Fruit* oblongoid, 5–8 mm long, 3–5 mm diam., the persistent stigma scar stylopodic, densely and prominently pellucid punctate-lineate.

Distribution.—*Myrsine oblongibacca* is endemic to the Philippines, occurring on the Island of Luzon, in Cagayan, Ilocos Norte, Nueva Ecija, Quezon, and Rizal provinces, and on the Island of Dinagat, just north of Mindanao Island. While no precise elevation has been listed on collections, one might surmise that it is a submontane species, and as such, would be expected at perhaps 800–1,500 m elevation.

Ecology and conservation status.—Virtually nothing is known of the ecology of *M. oblongibacca*. It is known only from historical collections, and recent expeditions made to the areas from which it was previously known have not resulted in recollections. However, Mt. Palimlim (Ilocos Norte), and Dinagat Island are areas containing significant pockets of vegetation on ultramafic soils. Therefore, it is possible that this species is another ultramafic specialist. Given the scanty remnants of forests left in the country, it is doubtful that we will ever know the natural distribution of *M. oblongibacca*. It is assumed that the species is highly endangered if not already extinct.

Etymology.—The specific epithet refers to the oblongoid fruit, a rarity among species of the genus.

Common names.—"Supak" (Igorot language, Madulid 1992).

Specimens examined. **PHILIPPINES**. **LUZON ISLAND**. **Cagayan Prov.**: Mt. Cagua Volcano, Oct–Nov 1929 (fr), *G. Edaño* BS 78357 (K, NY, PNH), (fr), *G. Edaño* BS 78412 (NY), (ster.), *G. Edaño* BS 78424 (K, NY, PNH); Mt. Dos Cuernos, Apr 1929 (fr), *M. Ramos* BS 77034 (NY); Bauan District, Mt. Tabuan, May 1929 (fr), *M. Ramos* BS 77079 (NY); Mt. Balatongan, Nov 1929 (fr), *G. Edaño* BS 78533 (NY). **Ilocos Norte Prov.**: Mt. Palimlim, Aug 1918 (fr), *M. Ramos* BS 33311 (A, K, PNH, US). **Nueva Ecija Prov.**: Mt. Umingan, Aug–Sep 1916 (fr), *M. Ramos & G. Edaño* 26418 (A, K, PNH, US). **Quezon [Tabayas] Prov.**: Mt. Dingalan, Aug–Sep 1916 (fr), *M. Ramos & G. Edaño* BS 26548 (A, US). **Rizal Prov.**: Mt. Susong-Dalaga, Aug 1917 (fr), *M. Ramos & G. Edaño* BS 29386 (A, K, PNH). **DINAGAT ISLAND**. **Surigao del Norte Prov.**: May 1919 (fl bud), *M. Ramos & J. Pasgasio* BS 35194 (L).

Myrsine oblongibacca is most closely related to *M. amorosoana*, from which it is easily distinguished by its oblongoid fruits, and asymmetric, narrowly oblong or oblanceolate leaves with flat margins.

5. ***Myrsine cruciata*** (Philipson) Pipoly, comb. nov. (**Fig. 1H, I**). *Rapanea cruciata* Philipson, J. Bot. (London) 77:105. 1939. TYPE: MALAYSIA. SABAH [BRITISH NORTH BORNEO]: Pava Cave, Mt. Kinabalu, Upper Kinabalu, 2,400–3,050 m, 29 Mar 1932 (stam. fl), *J. & M. S. Clemens* 28941 (HOLOTYPE: BM, n.v.; ISOTYPES*: A!,

K!, L!, NY!). *The isotype at Kew contains two distinct elements, one-half of the sheet bearing a twig of *M. cruciata* and the other an entity close to, if not conspecific with, *M. dasyphylla* Stapf; and both sides were correctly annotated by Philipson. However, the sheet at A bears two twigs of still another unknown *Myrsine* species entity with very prominent secondary and tertiary leaf venation. Thus no portion of J. & M. S. Clemens 28941 housed at A corresponds to *R. cruciata*. On the sheet at NY, the left portion corresponds to *M. cruciata*, while the right hand portion to *M. dasyphylla* Stapf. The L sheet is entirely *M. cruciata*.

Shrub or tree to 5 m tall. *Branchlets*: angulate, 2.5–3.5 mm diam., somewhat lenticellate, glabrous. *Leaves*: buds with margins sparingly glandular-ciliolate, glabrescent; blade cartilaginous, symmetric, oblanceolate to oblong, (3–)6–9.5 cm long, 1.8–2.5 cm wide, apically rounded to obtuse, retuse to emarginate at very tip, basally cuneate, smooth and laccate above, pallid and conspicuously black-lineate and prominently black punctate along margin below, the midrib impressed above, prominently raised below, the secondary veins 16–22 pairs, scarcely or not visible above, scarcely visible below, the submarginal collecting vein ca. 0.5 mm from margin, entire and revolute along the margin; petiole marginate, 3–5 mm long, the midrib elevated medially adaxially, glabrous. *Staminate inflorescence*: subsessile, 2–5-flowered; peduncle ca. 2–3 mm long, ca. 1 mm diam.; floral bracts coriaceous, deltate, 1.5–2 mm long, 1–1.3 mm wide, apex acute or obtuse, the margin entire, glandular ciliolate; pedicels angulate, 2–3 mm long. *Staminate flowers*: 4–5-merous, chartaceous 3–3.5 mm long; calyx cotyliform, 2.3–2.8 mm long, the tube 0.3–0.4 mm long, the lobes ovate, 2–2.4 mm long, 1.2–1.5 mm wide, apically obtuse to acute, medially thickened, conspicuously (not prominently) black punctate, entire and densely glandular-ciliate along the margin; corolla rotate, 3.3–3.5 mm long, the tube 0.8–1.1 mm long, the lobes elliptic 2.3–2.5 mm long, 1–1.2 mm wide, apically obtuse, densely and prominently black-lineate medially, black punctate marginally, glandular-granulose along the margin and near the margin within; stamens 3–3.2 mm long, the filaments 0.8–1.1 mm long, connate and developmentally adnate to the corolla tube, the anthers oblong, 1.8–2 mm long, 1–1.2 mm wide, apically apiculate, basally cordulate, dehiscent by wide longitudinal slits, the connective eglandular; pistillode conic, ca. 0.3 mm long and diam., hollow. *Pistillate inflorescence*: like staminate but peduncle accrescent annually to 3 mm long, ca. 1 mm diam.; pedicels 2–2.5 mm long; floral bracts 1.5–2 mm long, 1–1.3 mm wide. *Pistillate flowers*: like staminate but 2.8–3 mm long, the tube 0.8–1.1 mm long, the lobes 1.9–2.2 mm long, 1–1.2 mm wide; staminodes 2.3–2.8 mm long, the filaments 0.6–1.1 mm long, the antherodes ovate, 2–2.2 mm long, 0.4–0.6 mm wide, apically acute, basally sagittate; pistil ellipsoid to subglobose, 2–2.2 mm long, 1.3–1.5 mm wide, the stigma ligulate, tortuous, ca. 1 mm long, stylopodic basally, the placenta subglobose,

the ovules 6–8, biseriate. *Fruit* ovoid to oblongoid, (3–)5–7 mm long, 3–5 mm diam., densely and prominently black punctate and punctate-lineate.

Distribution.—In the Philippines, *Myrsine cruciata* is known from the hills of Mt. Beaufort, above Puerto Princesa on the island of Palawan, and from unknown localities in Abra and Zambales provinces. Outside of the Philippines, it is known otherwise only from Mt. Kinabalu in Sabah, Malaysia. The altitudinal range of the species is 850 to 2,500 m elevation.

Ecology and conservation status.—*Myrsine cruciata* appears to be restricted to sandy soils on quartzite rocks. Regarding its conservation status, no recent collections have been made from Luzon, and those populations may be extinct. However, the populations in Palwan appear to be surviving so far. Given these circumstances, *Myrsine cruciata* should be considered a threatened species.

Etymology.—The specific epithet refers to the tetramerous perianth parts on the type specimen.

Common name.—"Tongog" (Bagobo language).

Specimens examined. **PHILIPPINES**. **LUZON ISLAND**. **Abra Prov.**: *sine loc. esp.* Jan–Feb 1909 (fr), *M. Ramos* BS 7263 (NY, US). **Zambales Prov.**: *sine loc. esp.*, Dec 1907 (fr), *M. Ramos* BS 5050 (NY, US). **PALAWAN ISLAND**. Municipality Puerto Pincesa, Mt. Beaufort, W spur, 815 m, 28 Mar 1984 (fr), *C. Ridsdale* SMHI 225 (A, K, L, PNH); Narra, Victoria Peaks, Trident Mining Co. Concession, 490–590 m, 18 May 1984 (fr), *C. Ridsdale* SMHI 1732A, *C. Ridsdale* SMHI 1741 (A, K, L, PNH), 620 m, 20 May 1984 (fr), *A. Podzorski* SMHI 2125 (A, CAHUP, K, L, PNH), *A. Podzorski* SMHI 2130 (A, K, L, PNH), 500 m, *J. Dransfield* SMHI 1292 (A, K, L, PNH). **MALAYSIA**. **SABAH**: Mt. Kinabalu, Pig Hill, 7,000 ft., 18 Feb 1964 (fr), *W. Chew & E. Corner* RSNB 4372 (K), 2,300 m, 24 Feb 1964 (fr), *W. Chew & E. Corner* RSNB 4493 (K), Upper Kinabalu, 1,830–4,115 m, 2 Jun 1932 (stam. fl), *J. & M. Clemens* 30258 (K); Mari Pari, 1,524 m, 27 Mar 1933 (fr), *J. & M. Clemens* 32378 (K).

While the population of *Myrsine cruciata* (*sensu stricto*) from the type locality has mostly oblong leaves instead of oblanceolate ones, and the texture is somewhat thicker, I have no doubt that the Philippine and Bornean populations are conspecific. This species has often been confused with *Myrsine oblongibacca*, but may easily be separated from it by the wider, symmetric leaf blades, angulate branchlets, and larger, mostly ovoid fruits. In most of its range through the Philippines, *Myrsine cruciata* is most readily compared to *M. densiflora*, but is immediately distinguished by the cartilaginous and laccate leaf blades with retuse to emarginate tips, and the larger fruit. *Myrsine cruciata* inhabits sandy soils on quartzite rocks, apparently adjacent to ultramafic substrates in submontane and montane habitats, while *M. densiflora* occurs on ultramafic soils behind coastal beaches.

6. *Myrsine densiflora* Scheffer, Comm. Myrs. Archip. Ind. 50. 1876. (Fig. 2A, D). *Rapanea densiflora* (Scheffer) Mez in Engler, Pflanzenr. 9 (IV. 236):365. 1902. TYPE: INDONESIA. IRIAN JAYA [WEST NEW GUINEA]: S coast, along Daurga

River, Princess Marianne Strait, May 1828 (stam. fl), *A. Zippelius s.n.* (HOLOTYPE: L, n.v., fragment, A!).

Shrub or tree to 3–5(–10) m tall. *Branchlets*: angulate, (3–)3.5–5 mm diam., longitudinally ridged, lenticellate with age, glabrous. *Leaves*: buds with margins densely glandular-ciliolate, glabrescent; blades coriaceous, symmetric, elliptic to obovate, rarely oblanceolate, (5.5–)6–14(–16) cm long, 3–5(–6) cm wide, apically broadly rounded to acute, basally cuneate, slightly decurrent on petiole, dull or somewhat nitid above, scrobiculate above and below, densely and conspicuously black punctate and punctate-lineate below, the midrib impressed above, prominently raised below, the secondary veins 13–17 pairs, prominulous above and below, connected by an inconspicuous submarginal collecting vein less than 0.5 mm from the margin, inrolled, densely and prominently black punctate below along the margin. *Staminate inflorescence*: fasciculate, 3–9-flowered; peduncle 2–3.5 mm long, 1–2 mm diam. (the longer peduncles apparently all on one year's growth); floral bracts coriaceous, deltate, 0.8–1.0 mm long and wide, apically rounded or obtuse, densely and prominently black punctate apically, the margin entire, glabrous; pedicels cylindric, 1.5–2 mm long, prominently reflexed at anthesis, conspicuously black lineate. *Staminate flowers*: 4-merous, chartaceous, 1.8–2.3 mm long; calyx cotyliform, 0.8–1.0 mm long, the tube ca. 0.2 mm long, the lobes widely ovate, 0.6–0.8 mm long, 0.7–0.9 mm wide, apically acute, medially prominently black punctate and punctate-lineate, the margin opaque, irregular, glabrous; corolla subrotate, 1.7–2.2 mm long, the tube ca. 0.1 mm, the lobes oblong or elliptic, 1.7–2.2 mm long, 0.7–1.0 mm wide, apically obtuse to rounded, medially densely and prominently black punctate throughout, punctate-lineate apically and medially, entire, and densely glandular-granulose along the margin, glabrous within; stamens 1.3–1.5 mm long, the filaments flat, adnate to adaxial corolla tube and lobe, inconspicuous, 0.2–0.3 mm long, the anther ovate to obcordate, 1.1–1.3 mm long, 0.5–0.7 mm wide, apically acute, basally broadly cordate, the connective densely and prominently brown punctate dorsally; pistillode conic, 0.2–0.3 mm long, 0.3–0.4 mm diam., hollow, without style or stigma. *Pistillate inflorescence*: like staminate but peduncle to 3 mm long, 2 mm diam.; pedicels 1.5–2.5 mm long. *Pistillate flowers*: like staminate but 1.3–1.5 mm long; calyx 0.6–1 mm long, the tube ca. 0.2 mm long, the lobes 0.5–0.7 mm long, 0.6–0.8 mm wide; corolla 1.3–1.5 mm long, the tube ca. 0.1 mm long, the lobes 1.2–1.4 mm long, 0.4–0.6 mm wide; staminodes like stamens but 0.7–0.9 mm long, the filaments ca. 0.1 mm long, the antherodes irregular, flat, deltate, 0.6–0.8 mm long and wide, apically acute, base not distinguishable; pistil 1.3–1.5 mm long; the ovary ellipsoid, 0.3–0.5 mm long, 0.2–0.3 mm diam.; stigma ligulate, 0.8–1 mm long, 0.2–0.3 mm wide, apically truncate; placenta

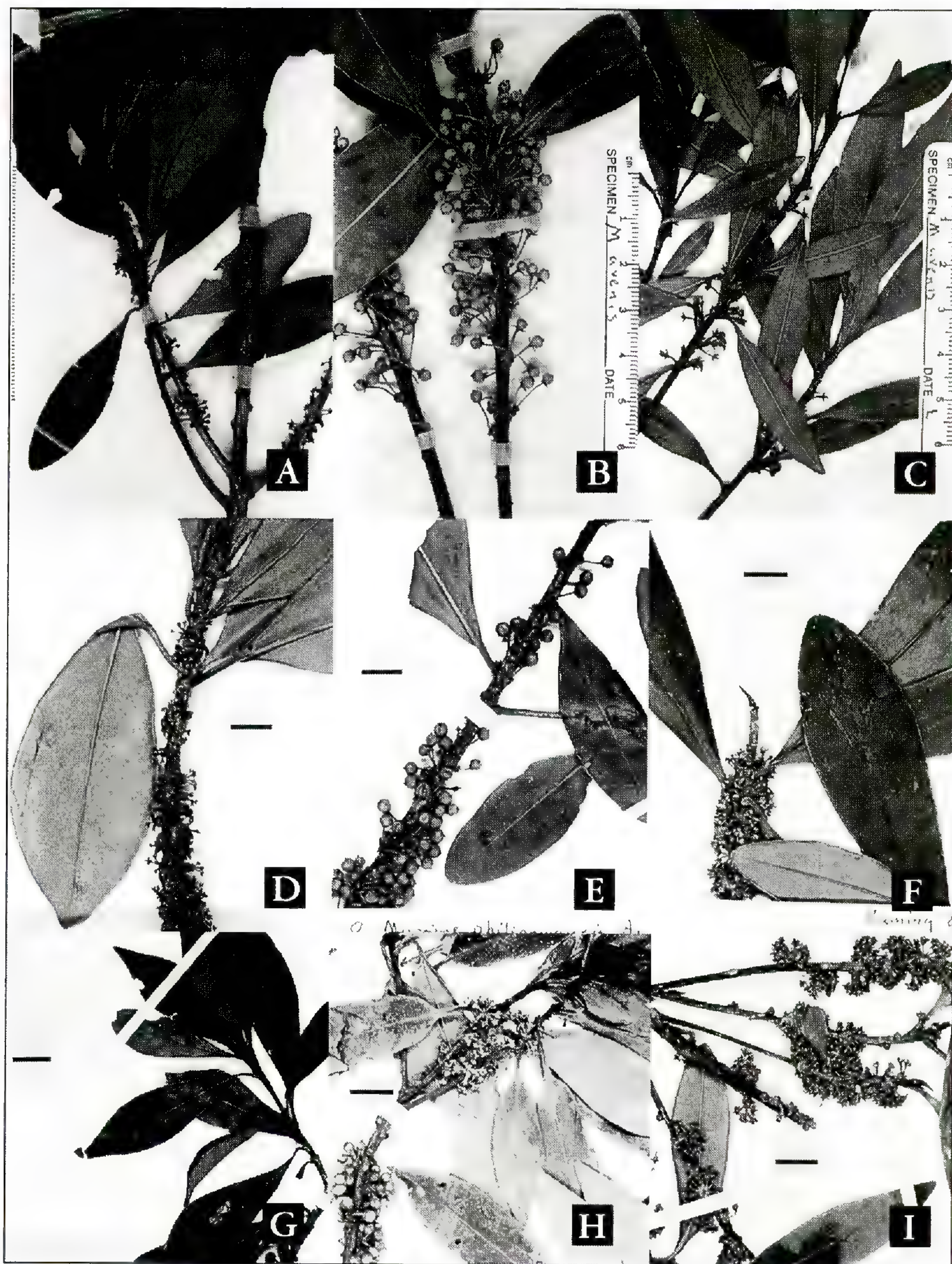


FIG. 2. A. *Myrsine densiflora* Scheffer, showing leaf shape convergent with *M. philippinensis*, (H. Lam 3373). B-C. *Myrsine avenis* (Blume) A. DC. B. Pistillate branch, showing long fruiting pedicels and inconspicuous venation of leaf blades (A. Elmer 14286). C. Staminate branch, showing leaf variation and sparse inflorescences (Lober 14097). D. *Myrsine densiflora*, growth form from Palawan, superficially resembling *M. aralioides* (C. Ridsdale 1084). E-F. *Myrsine philippinensis* A. DC. E. Pistillate branch, showing globose fruit (M. Ramos & J. Pagasio BS 34755). F. Staminate branch, showing inflorescence and leaf apices (isotype). G. *Myrsine mindanaensis* (Elmer) Pipoly, showing terete branchlets and globose fruits; (isotype) H-I. *Myrsine avenis* (Blume) A. DC. H. Pistillate branch (R. Williams 1346). I. Staminate branch. (C. R. Robinson 1408). Black scale bar equals 1 cm, smallest unit on white scales equals 1 mm.

subglobose, the ovules 2–3, uniseriate, immersed in the placenta. *Fruit* depressed-globose, 5–6 mm long and in diam., densely and prominently black punctate and punctate-lineate apically, the same punctation types but pellucid basally.

Distribution.—In the Philippines, this species is known from the Islands of Batan to Luzon (Pangasinan and Zambales provinces), Panay (Capiz Province), Negros (Negros Oriental Province), Samar Island (Western Samar Province), Dinagat (Surigao del Norte Province), Mindanao (Surigao City), and Palawan Island. Outside the Philippines, it is known from the Talaud Islands, Moluccas, Key Islands, Irian Jaya and Papua New Guinea, from sea level to 300 m.

Ecology and conservation status.—*Myrsine densiflora* occurs on ultramafic soils, just behind beaches in grasslands along streams at or near coastlines throughout its range. With ample habitat still remaining, the species does not appear to be threatened. The occurrence of *Myrsine densiflora* on Mt. Iraya on Batan Island might first be considered very unusual, but recent evidence shown by Richard et al. (1986) indicates that “Batan Island is noteworthy for the occurrence, within Mt. Iraya lavas, of ultramafic xenoliths (harzburgites, dunites, lherzolites, wehrlites, websterites) which have mantellic origin and had undergone strong interactions with metasomatic fluids.” Thus, similar geologic conditions, such as those found on Mindanao Island in the Provinces of Surigao del Norte and Surigao del Sur, and areas of southwestern Luzon (Zambales), allow us to predict that *Myrsine densiflora* may occur in these areas on ultramafic soils behind mangrove formations.

Etymology.—The specific epithet refers to the dense clusters of slender pedicels and flowers, often appearing congested in early flowering.

Common names.—“Tongog” (Bagobo language); “Maga” and “Magaspang” (Bisayan, Panay dialects).

Representative specimens examined: **PHILIPPINES**. **BATAN ISLAND**. Batanes Prov.: Mt. Iraya, 122°00'E, 20°28'N, 750 m, 4 Jul 1989 (stam. fl), E. Fernando 1003 (LBC), 800 m, 9–16 Nov 1964 (fr), S. Hatusima & M. Sato 29059 {PNH 111132} (PNH). **LUZON ISLAND**. Pangasinan Prov.: Dec 1907 (fr), M. Ramos s.n. (NY). Zambales Prov.: Acoje Mine Concession Area, Santa Cruz, ca. 15°46'N, 120°00'E, low elevation, 23 May 1986 (pist. fl bud), C. Ridsdale & E. Reynoso 1440 (A, K, L, LBC, PNH). **PANAY ISLAND**. Capiz Prov.: Below Mt. Salibongbong, Jul 1919 (fl bud), A. Martelino & G. Edaño BS 35612 (A). **SAMAR ISLAND**. Western Samar Prov.: Barangay Tinabanan, Marabut, 13 Feb 1992 (fr), Barbon et al. PPI 6094 (A, BOG, BRIT, K, L, PNH). **DINAGAT ISLAND**. Surigao del Norte Prov.: Loreto Municipality, 26 Sep 1991 (fr), F. Gaerlan et al. PPI 3476 (A, BRIT, K, PNH), 1902, (fr), G. Abern FB 444 (NY). **NEGROS ISLAND**. Negros Oriental Prov.: Sibulan, Kabalanan, Lake Balinsasayao, 23 May 1991 (fr), E. Reynoso et al. PPI 1087 (A, BO, BRIT, K, L, PNH, US). **PALAWAN ISLAND**. Palawan Prov.: N of Tagburos, ca. 17 km N of Puerto Princesa, 27 Oct 1985 (stam. fl), C. Ridsdale 1084 (A, K, L, PNH). **MINDANAO ISLAND**: Surigao Prov. [del Norte ?]: Apr 1919 (fr), M. Ramos & J. Pasgasio BS 34625 (NY), Jun 1919 (fr), M. Ramos & J. Pasgasio BS 34755 (A). Surigao del Norte Prov.: Surigao City,

Apr–May 1911 (pist. fl), *C. Piper* BS 237 (US). **INDONESIA. SULAWESI [CELEBES]. Talaud Islands:** Miangas Paui Baronlo, 11 Jun 1926 (stam. fl), *H. J. Lam* 3373 (BO, K); Karakelang, G. Piapi, 300 m 31 May 1926 (stam. fl), *H. Lam* 3258 (A, BO, K); Talaud, Merampi, 100 m, 13 Jun 1926 (stam. fl), *H. Lam* 3420 (BOG, K); Salawati, P. Rumbobo, *J. Teysmann* 7471 (BO, K). **MOLUCCAS:** Obi. Paui Santari, 2 m, 28 Nov 1937 (pist. fl), *Nedi* 665 (BO, K). **IRIAN JAYA:** West Irian Jaya: Seacoast below Sukarnapura (=Hollandia), 11 Aug 1966 (stam. fl), *A. Kostermans & Soegeng* 311 (BO, K). **PAPUA NEW GUINEA: W SEPIK DISTRICT:** Selio Island Aitape subdistrict, ca. 03°10'S, 142°30'E, sea level, 31 May 1969 (stam. fl), *A. Millar & J. Vandenberg* NGF40880 (K, LAE). **ADMIRALTY ISLANDS. Manus Island. Manus Prov.:** Lorengau Subprovince, Lorengau, 02°2'30" S, 147°15'30" E, 40 m, 22 Mar 1981 (stam. fl), *K. Kerenga et al.* LAE 77490 (K, LAE); Milne Bay, Subprovince Misima, 11°22'S, 154°11'E, 22 Mar 1979 (fr), *O. Gideon* LAE 76035 (A, LAE); Archip. Key, 1889 (pist. fl), *O. Warburg* 21830 (A-2 sheets); Eastern Highlands District, 06°23'S, 145°58'E, 2,300 m, 3 Jul 1963 (fr), *T. Hartley* 11955 (A, CSIRO, LAE).

Myrsine densiflora is very closely related to *M. philippinensis*, but is readily separated from it by the coriaceous leaves scrobiculate above and below, the leaf apices not emarginate or retuse at tip, and the smaller pedicels. The species has populations which at times contain individuals with extremely coriaceous leaves and rather robust, albethey short, peduncles (*C. Ridsdale* 1084), resulting in confusion with *Myrsine aralioides* (Philipson) Pipoly. However, the depressed-globose fruit is unique among species of *Myrsine* in the region. *Myrsine densiflora* is restricted to ultramafic soils behind beach formations at low elevations, while *M. aralioides* is clearly a montane forest species. The edaphic specificity of the species and narrowly defined ecological tolerances account for its rather spotty distribution. While *Myrsine densiflora* may appear to be parapatric with *M. philippinensis*, the latter is a mangrove species, occurring in the mangrove proper with such other species as *Aegiceras corniculatum* (Myrsinaceae).

7. *Myrsine peregrina* (Mez) Pipoly, comb. nov. (Fig. 3F, G). *Rapanea peregrina* Mez, Repert. Spec. Nov. Regni Veg. 16:424. 1920. TYPE: PHILIPPINES. MINDANAO ISLAND. Davao del Sur Prov.: Camp Keithley, Lake Lanao, Jun 1907 (fr), *M. S. Clemens* 917 (HOLOTYPE: PNH-destroyed; LECTOTYPE, here designated: US!; ISOLECTOTYPE: A!).

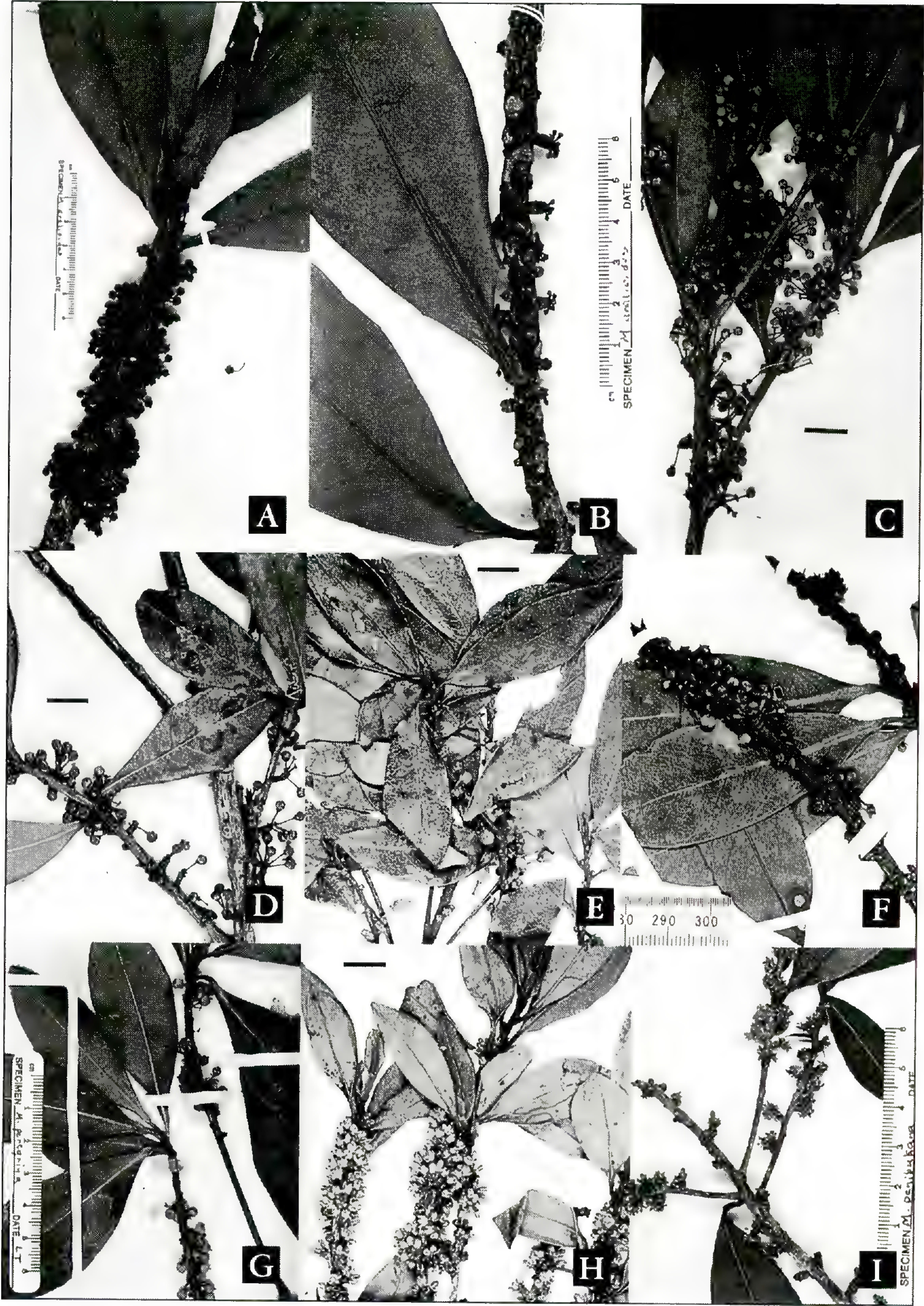
Rapanea venosa Elmer, Leaflet Philipp. Bot. 2:672. 1910. *non Rapanea venosa* (A. DC.) Mez, Pflanzenreich 9(IV. 236):386. 1902, *nec Myrsine venosa* A.DC., Ann. Sci. Nat., Ser. 2, 16:86. 1841. TYPE: PHILIPPINES. MINDANAO ISLAND. Davao Prov.; Mt. Apo (Todaya), District of Davao, 2,000 m, Aug 1909 (stam. fl), *A. Elmer* 11445 (HOLOTYPE: PNH-destroyed; LECTOTYPE, here designated: GH!, ISOLECTOTYPES: A!, BISH!, K!, L!, NY!).

Tree to 6 m tall. *Branchlets:* angulate, 2–3 mm diam., glabrous. *Leaves:* buds with margins sparsely translucent-ciliate, glabrescent; blades coriaceous, asymmetric, oblanceolate to elliptic, 5–12 cm long, 1.5–3.5 cm wide, apically short-acuminate, the acumen ca. 3–7 mm long, basally obtuse or rarely acute, nitid, densely and prominently pellucid punctate above, pallid below, midrib immersed above, prominently raised below, the second-

ary veins 21–32 pairs, prominulous above, less conspicuous below, the submarginal collecting vein ca. 0.5 mm from margin, entire, revolute, and bordered by numerous prominently pellucid punctations below along margin; petiole marginate, 6–11 mm long, glabrous. *Staminate inflorescence*: umbellate, sessile to subsessile, 3–9-flowered, the peduncle obsolete to 2.5 mm long, ca. 1.0 mm diam.; floral bracts coriaceous, widely ovate, 0.8–1 mm long, 0.9–1.2 mm wide, apex rounded, the margin entire, sparsely glandular-ciliate, glabrescent; pedicels obconic, 3–5 mm long, reflexed in anthesis. *Staminate flowers*: chartaceous, 4-merous, 2.2–2.5 mm long; calyx cotyliform, 1–1.3 mm long, the tube ca. 0.1 mm long, the lobes ovate, 0.9–1.2 mm long, 0.5–0.8 mm wide, apically acutish to obtuse, densely and prominently red punctate, sparsely red punctate-lineate, irregular and glandular-ciliate along the margin; corolla rotate, 1.8–2.2 mm long, the tube ca. 0.2 mm long, the lobes 1.6–2 mm long, 0.8–1 mm wide, apically obtuse, cucullate, densely and prominently red punctate-lineate medially, red punctate near margins, on the margins densely glandular-granulose, stamens 1–1.5 mm long, the filaments ca. 0.3 mm long, developmentally fused to adaxial corolla tube and adjacent lobe, the anthers broadly ovate, 1–1.2 mm long, 0.8–1 mm wide, apically obtuse to rounded, basally subcordate, dehiscent by wide longitudinal slits, the connective brownish punctate apically and just above point of filament attachment; pistillode conic, ca. 1 mm tall, 0.8 mm wide, the placenta with two minute, infertile ovules. *Pistillate inflorescence*: like staminate but peduncle 1–5 mm long, ca. 1 mm diam. (breaking off at extreme length); pedicels 0.5–3.5, accrescent in fruit. *Pistillate flowers*: like staminate but 1.8–2.2 mm long, calyx 1.2–1.4 mm long, 0.5–0.4 mm wide, apex acute; corolla 1.8–2 mm long, the tube 0.5 mm long, the lobes 1.3–1.5 mm long, the apically acute; staminodes 1.3–1.5 mm long, the tube adnate to the corolla tube, the antherodes deltate, malformed, 0.5–0.7 mm long, apically acute, basally sagittate, hollow; pistil obnapiform, the ovary globose, 1.3–1.5 mm long and in diam., the stigma stylopodic, lobed, 0.3–0.5 mm long, the placenta ovoid, the ovules 4, uniseriate. *Fruit* subglobose, longer than wide, 2.5–3.5 mm long, 2.2–3 mm diam., prominently red punctate-lineate.

Distribution.—*Myrsine peregrina* is endemic to the Philippines, occurring from northern Luzon Island (Batan) southward through Luzon, Mindoro and Panay, to Mindanao Island from 2,090–2,800 m elevation.

Ecology and conservation status.—*Myrsine peregrina* occurs in local populations, at the interface of the submontane and montane “mossy forests,” in areas with high incident light. The type of *Rapanea peregrina* was collected in a swamp near Lake Lanao. I have observed it to be extremely localized, and where it occurs, there are approximately 12 individuals per hectare, rarely reaching 9 cm DBH. This species seems to thrive in areas of distur-



bance, such as gaps produced by natural or man-made treefalls, so it appears resilient enough to consider it not threatened at this time.

Etymology.—The specific epithet means “travelling and migratory,” perhaps alluding to this species broad distribution atop mountains throughout the country.

Common names.—“Marimbakawan” (Palawean and Tagbanwa languages); “Korios” (Bisayan-Cebuano dialect)- generic term related to long terminal bud; “Tongog” (Bagobo language).

Specimens examined: **PHILIPPINES. BATAN ISLAND. Batanes Prov.**: Mt. Iraya, Jun–Jul 1930 (stam. fl), *M. Ramos* BS 80268 (A). **LUZON ISLAND. Mountain Prov. [Bontoc]**: Mt. Caua, Mar 1920 (stam. fl), *M. Ramos & G. Edaño* BS 37982 (K, PNH); Bontoc Sub-Prov., Bauko, On slopes of Mt. Data 2,100–2,500 m, 10–13 Feb 1964 (fr), *W. Stern & J. Rojo* 2299 [PNH 92363] (CLP, PNH). **Nueva Ecija Prov.**: Mt. Umingan: Aug–Sep 1916 (fr), *M. Ramos & G. Edaño* BS 26397 (A, US). **MINDORO ISLAND. Mindoro Oriental Prov.**: Mt. Halcon, Mar 1922 (pist. fl, fr), *M. Ramos & G. Edaño* BS 40712 (A, K, L, PNH, US); NE summit, 2,000–2,450 m, Apr–May 1995 (ster), *E. Mandia* 555 (CAHUP, DLSU, PNH). **PANAY ISLAND. Capiz Prov.**: Mt. Bulilao, Jun 1919 (stam. fl), *A. Martelino & G. Edaño* BS 35682 (A). **Iloilo Prov.**: Iwa Ilaya [Iwaya] to Coyaoyao [Koya], 10 Sep 1936 (stam. fl), *T. Hosokawa* 8560 (BISH). **MINDANAO ISLAND. Bukidnon Prov.**: Mt. Katanglad, Mar 1949 (fr), *M. Sulit* PNH 10054 (A, L, PNH, US), 14 Apr 1949 (fr), *M. Sulit* PNH 10125, (A, K, L, PNH), Mar–Apr 1949 (fr), *G. Edaño* PNH 11595 (A, PNH); Municipality Lantapan, Sitio Sungco, Mt. Kinasalapi, part of Kitanglad Mt. Range, W of Analib River, ca. 08°00'05" N, 124°30'26" E, 2,090–2360 m, 16 Nov 1994 (fr), *J. Pipoly et al.* PPI 16584 (BRIT, PNH); Bukidnon, Kaatoan, above *Cinchona* plantation, 1,000 m, 10 Oct 1953 (ster.), *B.B. Britton* 421 {PNH 19646} (L, PNH). **Davao Prov.**: Mt. McKinley, E slopes, 2,250 m, 25 Sep 1946 (fr), *G. Edaño* 1051 {PNH 1564} (L, PNH); Mt. Apo, near Sulphur Spring, 2,100 m, 15 Nov 1946 (fr), *G. Edaño* 1536 {PNH 1540} (L, PNH). **Davao del Sur Prov.**: Mt. Apo, [Todaya], N slope, Lake Lanao, 2,100 m, 30 Oct 1946 (fr), *G. Edaño* 1232 {PNH 1412} (L, PNH); Mt. Kampalili, Mar–Apr 1949 (fr), *G. Edaño* PNH 11565 (A, K, L-2 sheets, PNH, US); PNH 11595 (A, L, PNH, US); Mt. Apo, Baklayan, 1,800 m, 11 Nov 1946 (fr), *G. Edaño* 1445 (PNH 1557) (A, L), 15 Nov 1946 (pist.fl), *G. Edaño* 1535 (PNH 1553) (A), Mt. Apo, 1,970 m, 13 Mar 1956 (fr), *J. Pancho* 2587 {CAHUP 4124} {PNH 34613} (CAHUP, PNH). **Misamis Oriental Prov.**: NE slopes of Mt. Malindang, Lake Duminagat, 1,763 m, 5 Jan 1993 (fr), *F. Gaerlan et al.* PPI 10949 (A, BO, BRIT, K, L, PNH); Mt. Malindang, *M. Mearns & W. Hutchinson* FB 4573 (FS). **North Cotabato Prov.**: [Todaya] Mt. Apo, 2,134 m, Aug 1909 (pist. fl, fr), *A. Elmer*

FIG. 3. A-B. *Myrsine aralioides* (Philipson) Pipoly. A. Pistillate branch, showing infructescences (*J. & M. Clemens* 27801). B. Staminate branch. (*J. & M. Clemens* 50807). C. *Myrsine glandulosa* (Elmer) Pipoly, pistillate branch, showing elongate peduncles (isotype). D. *Myrsine fastigiata* (Elmer) Pipoly, pistillate branch. (*M. Ramos & G. Edaño* 38494 (isotype) F-G. *Myrsine peregrina* (Mez) Pipoly. F. Pistillate branch showing leaf texture (isotype, *Rapanea venosa* Elmer). G. Pistillate branch (lectotype). H. *Myrsine fastigiata* (Elmer) Pipoly, staminate branch, showing crowded fascicles (*M. Jacobs* 7564). I. *Myrsine penibukana* (Philipson) Pipoly, staminate branch showing perennating peduncles forming “short shoots” (*J. & M. Clemens* 50295). Black scale bar equals 1 cm, smallest unit on white scales equals 1 mm.

11456 (A, BISH, GH, K, L, NY, PNH, US); Mt. Apo, 7,000 ft, 15 Nov 1946 (pist. fl, fr), *G. Edaño* PNH 1540 (A, PNH), 15 Nov 1946 (pist. fl), *G. Edaño* PNH 1553 (A, PNH); Kidapawan Municipality, Mt. Apo Geothermal Project, Lake Venado, 11°32'N, 125°21'E, Oct 1992 (fr), *D. Lagunzad* 870 (PUH). Site C1, 06°59.8'N, 125°14'E, 1,725 m, Oct 1992 (fr), *D. Lagunzad* 961 (PUH). **South Cotabato Prov.:** Mt. Matutum, 7,000 ft. Apr 1932 (fr), *M. Ramos & G. Edaño* BS 85048 (A), 15 Apr 1992 (fr), *F. Gaerlan et al.* PPI5361 (A, BRIT, K, L, PNH, US). **PALAWAN ISLAND.** **Palawan Prov.:** Lipun Island, Lipun Peak, 215 m, 28 Apr 1964 (fr), *D. Mendoza* PNH 91353 (L, PNH).

Myrsine peregrina can be confused with *M. densiflora*, but is easily distinguished by the longer, obconic pedicels, short-acuminate and asymmetric leaf blades.

8. *Myrsine mindanaensis* (Elmer) Pipoly, comb. nov. (Fig. 2G). *Rapanea mindanaensis* Elmer, Leaf. Philipp. Bot. 2:671. 1910. TYPE: PHILIPPINES. MINDANAO ISLAND. North Cotabato Prov.: [Todaya], Mt. Apo, Aug 1909 (fr), *A. Elmer* 11332 (HOLOTYPE: PNH-destroyed; LECTOTYPE: K !; ISOLECTOTYPES: A!, BISH!; GH!, L!, NY!).

Shrub or tree to 8 m tall. *Branchlets:* terete, longitudinally ridged, 2.5–3.5 mm diam., sparsely and minutely rufous-papillose, early glabrescent. *Leaves:* buds essentially glabrous, the margins minutely rufous glandular-ciliolate, early glabrescent; blades chartaceous, slightly asymmetric, narrowly oblanceolate to narrowly oblong, 4.5–11.5 cm long, (1.8–)2–3.5 cm wide, apically acuminate, the acumen 0.5–1 cm long, basally acute, decurrent on the petiole to base, scrobiculate and inconspicuously punctate above, densely and prominently black punctate and punctate-lineate below, the midrib deeply impressed above, prominently raised below, the secondary veins all inconspicuous, ca. 8–10 pairs, the submarginal collecting vein inconspicuous, ca. 1 mm from margin, the margin slightly revolute throughout; petiole marginate to base, 6–7 mm long, flat above. *Staminate inflorescence:* unknown. *Pistillate inflorescence:* a sessile umbel, 3–9-flowered; peduncle obsolete to 2 mm long, ca. 1 mm diam.; floral bracts chartaceous, oblate, 1.3–1.5 mm long, 2–2.2 mm wide, apex broadly rounded, densely glandular-granulose at first, glabrescent, densely and prominently red glandular-punctate and punctate-lineate, the margin opaque, densely glandular-ciliate; pedicels cylindric, 3–5 mm long. *Pistillate flowers:* unknown. Fruiting calyx 4-merous, 0.8–1 mm long, the calyx tube ca. 0.1 mm long, the lobes ovate, 0.7–0.9 mm long, 0.5–0.7 mm wide, apex subacuminate, densely red punctate and punctate-lineate medially, the margin flat, opaque, entire, minutely glandular-ciliolate, glabrescent. *Fruit* globose, 2–3 mm long and in diam., densely and prominently red punctate and punctate-lineate, the persistent stigma ligulate, 4-winged.

Distribution.—Endemic to the Philippines, from southern Luzon Island

(Camarines Sur Province) southward through Leyte Island (Biliran Subprovince) to Mindanao Island (Davao del Sur and North Cotabato provinces), at 895–2,200 m elevation.

Ecology and conservation status.—*Myrsine mindanaensis* is a narrow endemic found from southern Luzon Island southward through Leyte to Mindanao. The species appears to be a subcanopy species on Mt. Apo, in the mid-montane forest dominated by *Lithocarpus* spp. and *Agathis philippinensis*. It is locally common in secondary growth areas on Leyte. However, no studies have shown whether *M. mindanaensis* can withstand prolonged disturbance. Therefore, pending further study, I prefer to describe its conservation status as threatened.

Etymology.—The specific epithet refers to the site of original description, from the island of Mindanao.

Common names.—“Dipallá” (Bagobo language, Ramos BS 41559); “Tongog” (Bagobo language); “Baliyuk” (Bagobo language, Madulid 1992).

Specimens examined. **PHILIPPINES. LUZON ISLAND.** Camarines Sur Prov.: Tinambac, Mt. Isarog, Haribon Foundation, Tinambac Cawaynan access trail N to Ulag Ganabo, Balagbag Kulod facing Isarog Tilhang, Ulag and vicinity, 895–1020 m, 20 Feb 1993 (fr), B. Hernaez & M. Cajano {CAHUP 6092, 60893, 60894} (CAHUP). **LEYTE ISLANDS.** Biliran Subprov.: Libtong, Naval, 12 Aug 1992 (fr), Barbon et al. PPI 8601 (A, BOG, BRIT, K, L, PNH). Leyte Prov.: Cabalian, Dec 1922 (fr), M. Ramos BS 41559 (A, NY, PNH, US). **MINDANAO ISLAND.** Davao del Sur Prov.: Davao, Aug 1933 (fr), R. Kanehira s.n. (NY). North Cotabato Prov.: [Todaya] Mt. Apo, Sep 1909 (fr), A. Elmer 11820 (A, BISH, GH, K, L, NY, PNH, US); Mt. Apo, NW slopes, along Marber River, 07°05'N, 125°14'E, 1,600 m, 23 Oct 1990 (ster.), L. Co 3125 (A, PUH, L); Kidapawan Municipality, Mt. Apo Geothermal Project, near Lake venado, 07°10'N, 125°16'E, 1,800–2,200 m, Oct 1992 (ster.), D. Lagunzad 916 (PUH).

Myrsine mindanaensis is closely related to *M. philippinensis* but can be distinguished by its scrobiculate upper leaf surface, minutely rufous papillose branchlet apices, and minute calyx.

9. *Myrsine philippinensis* A. DC. in DC., Prodr. 8:94. 1844. (Fig. 2E, F). *Rapanea philippinensis* (A. DC.) Mez in Engler, Pflanzenr. 9 (IV. 236):364. 1902. TYPE: PHILIPPINES. LUZON ISLAND. Albay Prov.: 1841, H. Cuming 868 (HOLOTYPE: G, n.v., fragment- A!; ISOTYPES: K-2 sheets!, L!).

Shrub or small tree to 5 m tall. *Branchlets*: terete, 2.5–3.5 mm diam., essentially glabrous. *Leaves*: buds minutely red glandular-papillate and translucent glandular-granulose, early glabrescent, the margin minutely translucent ciliate, early glabrescent; blade coriaceous, symmetric, oblanceolate or oblong, rarely elliptic, (5–)6–10(–12) cm long, 2–3(–3.8) cm wide, apically obtuse to rounded, the uppermost tip slightly emarginate, basally cuneate, decurrent on the petiole, smooth and inconspicuously pellucid punctate above, black or brown punctate and punctate-lineate below, the

midrib slightly raised above, prominently raised below, the secondary veins 13–19 pairs, not visible above, inconspicuous below, the marginal collecting vein ca. 1 mm from margin, flat, entire, and bordered by numerous prominent black punctations along the margin; petiole canaliculate and marginate, 6–8 mm long, glabrous. *Staminate inflorescence*: umbellate, 9–16-flowered; peduncle 1.5–2 mm long, 1–1.5 mm diam.; floral bracts chartaceous, ovate, 0.8–1 mm long, 0.3–0.5 mm wide, apically obtuse, prominently and densely pellucid punctate-lineate, the margin entire, glandular-ciliate; pedicels cylindric, 3.2–5.0 mm long. *Staminate flowers*: 4-merous, membranaceous, 2.6–3.6 mm long; calyx cotyliform, 1.2–1.5 mm long, the tube ca. 0.1 mm long, the lobes ovate, 1.1–1.4 mm long, 0.4–0.6 mm wide, apically obtuse, prominently black punctate near apex, erose and densely glandular ciliate along the margin; corolla 2.5–3.5 mm long, subrotate, the tube ca. 0.3 mm long, the lobes oblong, 2.2–3.2 mm long, 0.6–0.8 mm wide, apically rounded, prominently and densely black punctate and punctate-lineate, densely glandular-granulose along the margin; stamens 1.7–2 mm long, the filament adnate to corolla tube, 0.3–0.5 mm long, the anthers oblong, 1.3–1.5 mm long, apically long-apiculate, the apiculum densely glandular-barbate, basally subcordate, dehiscent at first by large subapical pores, opening into wide longitudinal slits, the connective and apiculum prominently black punctate ventrally and dorsally; pistillode conic, subglobose, ca. 0.1–0.2 mm long, 0.4–0.5 mm diam., hollow, the stigma apiculate. *Pistillate inflorescence*: like staminate but peduncle 2–4 mm long, to 1 mm diam.; pedicels 2–3 mm long, accrescent in fruit to 5 mm. *Pistillate flowers*: like staminate but 1.7–2 mm long; calyx 1.0–1.1 mm long, the tube ca. 0.2 mm long, the lobes widely ovate, ca. 0.8–0.9 mm long, 0.9–1.0 mm wide, apically rounded, the margin irregular, densely glandular-ciliate; corolla 1.7–1.9 mm long, the tube 0.1–0.2 mm long, the lobes 1.3–1.5 mm long, 0.3–0.5 mm wide; staminodes 1.3–1.5 mm long, the filaments 0.1–0.2 mm long, the antherodes lanceolate, 0.8–1 mm long, 0.2–0.4 mm wide, apically minutely apiculate, base subcordate; pistil obnapiform, 2.2–2.5 mm long; ovary globose, 1–1.2 mm long, 0.4–0.6 mm diam., the stigma ligulate, 1.4–1.6 mm long, the base stylopodic at the ovary apex, translucent, eglandular, the placenta obpyramidal to obovoid, ovules 3–5, uniseriate, exposed laterally. *Fruit* globose, 2.5–4 mm long and in diam., densely and prominently pellucid punctate and punctate-lineate.

Distribution.—Endemic to the Philippines, from southern Luzon Island (Batangas, Camarines Norte and Quezon provinces), southward through Mindoro, Sibuyan and Panay Island, then westward to the Cuyo Island Group and eastward to Mindanao, including Sulu Island, at sea level to 305 m elevation.

Ecology and conservation status.—*Myrsine philippinensis* is very common along coastal arelike secondary vegetation, and on sands in mangrove swamps, and as such does not appear to be threatened at the present time.

Etymology.—The specific epithet refers to the distribution of this endemic species.

Common names.—*Myrsine philippinensis* has more common names than any other species in the genus, owing to its high frequency and visibility in the mangroves along coastlines. The following are common names from label data with no languages given: “Mamumboga” (Panay Islands: Guimaras Subprovince, Guimaras Island); “Hampupuyos” (Panay Islands, Iloilo Prov.); “Maga” (Luzon Island: Quezon Prov.); “Naling Saging” (Samar Island: Northern Samar Prov.: Waray). Other names (Madulid 1992): “Anumbaga” (Bisayan-Panay dialect); “Go-od go-od” (Tagalog language); “Gurimomo” (Ibanag language); “Hanigad” (Bisayan-Cebuano dialect); “Kalumanay” (Tagalog language); “Lipote” (Bukidnon-Binukid Manobo dialect- probably from vicinity of Cagayan de Oro); “Luklukso” (Ibanag language); “Maga, Magaspang” (Bisayan-Panay dialect- probably mistaken and refers to *Myrsine densiflora*); “Malatukba” (Batangan, Mangyan dialect); “Marupig” (Negrito language); “Supak” (Igorot language); “Supek” (Kankanay language).

Specimens examined: **PHILIPPINES. LUZON ISLAND. Batangas Prov.:** 1841 (pist. fl), *H. Cuming* 1601 (A, K). **Camarines Norte Prov.:** Paracale, Nov 1884 (fr), *S. Vidal* 1516 (K, L). **Quezon Prov.:** Polillo Island, Bo. Lube, sea level, Jun 1946 (bisex. and pist. fl), *F. Salvoza* 1057 (PNH 3715) (A, L); Real, Lalawinan, Tipuan, NBG, 4 Sep 1991 (fr), *Barbon et al.* PPI 2267 (A, BRIT, PNH); Infanta, 3 m, 5 Aug 1959 (stam. fl), *L. Orantia* LBC 3481 (LBC); Tagkawayan, sea level, 20 Mar 1951 (stam. fl), *S. Jacoban* 20 {LBC 966} (LBC), 6 Jan 1951 (stam. fl), *E. Agaceta* 6 {LBC 917} (LBC); Calauag Bay, Caluag Municipality, near sea level, Mar 1990 (stam. fl), *D. Lagunzad* 758 (PUH). **MINDORO ISLAND. Mindoro Oriental Prov.:** Baco, Jan 1903 (pist. fl), *E. Merrill* 1206 (K, NY). **SIBUYAN ISLAND. Prov. Romblon:** Magallanes (Mt. Guiting-guiting), along Pauala River, 305 m, Apr 1910 (pist. fl), *A. Elmer* 12295 (A, BISH, GH, K, L, NY, PNH, US). **CUYO ISLAND GROUP: Palawan Prov.:** Pamalican Island, Hill 38, summit area, 11°21'N, 120°43.6'E, <50 m, 5 Apr 1990 (ster.) *L. Co.* 3073 (PUH). **PANAY ISLAND. Guimaras Subprov.:** Guimaras Island, Mar. 1808 (ster.), *S. Vidal* 3183 (K), Jan 1904 (ster.), *J. Gammill* FB 272 (K, NY, PNH, US), Jan 1904 (stam. fl), *J. Gammill* FB 276 (K, NY, PNH, US), Feb 1904 (fr), *J. Gammill* FB 301 (K, NY, PNH), Feb–Mar 1950 (fr), *M. Sulit* 3630 {PNH 11769} (A, K, L, PNH, US), (fr), *M. Sulit* 11800 (L, PNH, US), Guimaras, s.d. (Bud), *S. Vidal* 3156, 3183 (A). **LEYTE ISLAND. Leyte Prov.:** 19 Jun 1915 (pist. fl), *C. A. Wenzel* 1368 (A). **SAMAR ISLAND. Samar Norte Prov.:** Capul Island, 27 Mar 1957 (ster.), *Y. Kondo & G. Edaño* 113 {PNH 36799, 36817} (BISH, PNH); Tarangan, sea level, s.d. (stam. fl), *E. Rodulfa* EVR-7 {LBC 3792} (LBC). **MINDANAO ISLAND. Surigao Prov.:** Jun 1919 (fr), *M. Ramos & J. Pasgasio* BS 34755 (K, PNH). **JOLO [SULU] ISLAND. Samales Group: ARMM,** 15 Oct 1915 (stam. fl), *M. S. Clemens* 9332 (A, L).

Myrsine philippinensis belongs to a complex of species including *M. umbellulata* (Wallich) A. DC., *M. sumatrana* Miquel, *M. cochinchinensis* A. DC., *M. korthalsii* Miquel, and *M. rawacensis* A. DC. Field studies of popu-

lation biology and intrapopulation variation will be necessary to determine if the quantitative differences in pedicel length, floral number, and leaf reticulation provide useful characters upon which taxa may be consistently separated. These highly variable quantitative characters, combined with differences attributable to sex expression (staminate, pistillate, bisexual) may account for the proliferation of names in this group. In particular, there appears to be only minor petal ornamentation differences which tentatively separate *Myrsine philippinensis* from *M. cochinchinensis*. It is hoped that current studies underway across the entire Malesia Floristic Province will remedy the current taxonomic chaos.

In the Philippines, *Myrsine philippinensis* may be superficially confused with *M. mindanensis*, but is easily recognized by its glabrous branchlets, longer calyx and mangrove habitat. It is probably most often confused with *M. densiflora*, from which it is distinguished by the extremely small, globose fruit, more robust, longer pedicels, more numerous-flowered inflorescences, and much longer calyx.

10. *Myrsine avenis* (Blume) A. DC., Trans. Linn. Soc., Bot. 17:107. 1834.

(Fig. 2H, I). *Ardisia avenis* Blume, Bijdr. 691. 1825. *Rapanea avenis* (Blume) Mez in Engler, Pflanzenr. 9(IV. 236):357. 1902. TYPE: INDONESIA. JAVA: *sine loc. esp.* (fr), H. Zollinger 883 (HOLOTYPE: L, n.v.; ISOTYPES: A!, K!).

Tree to 8 m tall. *Branchlets*: angulate, 3–5 mm diam., densely rufous tomentose at first, glabrescent. *Leaves*: buds densely rufous tomentose and with minute rufous sessile scales, the margins densely rufous-ciliate, glabrescent; blade coriaceous, symmetric, elliptic to oblong, rarely narrowly oblanceolate, (3.8–)4–7(–9.5) cm long, (1.0–)2–3(–4) mm wide, apically sharply acute, with a small emargination at tip, basally obtuse to rounded, not decurrent on the petiole, dull but prominently pellucid punctate above, densely and prominently pellucid punctate below, bearing minute rufous sessile scales when young, glabrescent, midrib immersed above, to base of petiole, prominently raised below, the secondary veins not visible above or below, entire and subrevolute, especially basally, along the margin; petiole marginate, 10–15 mm long, glabrous. *Staminate inflorescence*: subsessile, the peduncle 1–2 mm long, ca. 1 mm diam.; floral bracts chartaceous, ovate to suborbicular, 0.8–1 mm long, 0.6–0.8 mm wide, apically obtuse, densely and prominently black punctate, the margin glandular-ciliate; pedicels cylindric, (2–) 3–11 mm long. *Staminate flowers*: 4-merous, chartaceous, 1.5–1.8 mm long; calyx cupuliform, 1–1.2 mm long, the tube ca. 0.2 mm, the lobes ovate, 0.8–1 mm long, 0.7–0.9 mm wide, apically obtuse, prominently red punctate-lineate medially, entire, densely and prominently red punctate and sparingly glandular-ciliolate along the margin; corolla campanulate, 2.3–2.5 mm long, the tube ca. 0.2 mm long, the lobes asym-

metrical, oblong, 2–2.3 mm long, 1–1.3 mm wide, apically obtuse to rounded, densely and prominently red punctate and punctate-lineate medially, densely red punctate and glandular-granulose along the margin; stamens 2–2.2 mm long, the filaments adnate to the corolla tube 0.2–0.3 mm long, the anthers ovate, 1.8–1.9 mm long, 1.2–1.5 mm wide, apically acute, almost apiculate, basally cordulate, the apiculum and connective darkened; pistillode conic, ca. 1 mm long and wide, hollow. *Pistillate inflorescence*: as in staminate but 10–15-flowered; peduncle 2.5–3 mm long, 1–1.5 mm diam.; floral bracts suborbicular, 1–1.2 mm long and wide, apically widely rounded, the margin glandular ciliolate; pedicels 1.5–3 mm long. *Pistillate flowers*: like staminate but calyx 1–1.3 mm long, the tube ca. 0.3 mm long, the lobes widely ovate, 0.8–1 mm long, 0.8–1 mm wide, apically obtuse; corolla 2.3–2.5 mm long, the tube ca. 0.3 mm long, the lobes oblong, 2–2.2 mm long, 0.8–1 mm wide, apically rounded, densely and prominently red punctate and punctate-lineate medially, punctate and glandular-granulose along the margin; staminodes 2 mm long, the filament fused to the corolla tube 0.3 mm long, the antherodes ovate, 0.5–0.7 mm long and wide, the apically acute, slightly apiculate, non functional, basally deeply cordate, the connective darkened apically and on filament back; pistil tetragonal in cross-section, 1.2–1.6 mm long; ca. 0.8–1 mm diam., densely black punctate-lineate, the stigma 4-lobed, the lobes perpendicular, ca. 0.2 mm long, the placenta ovoid, the ovules 4, in one series. *Fruit* globose, 1.5–2.5 mm long and in diam, red when fresh, densely and prominently orange and pellucid punctate, the persistent stigma base appearing stylopodic.

Distribution.—*Myrsine avenis* is found from northern Luzon Island south through Mindoro to Negro and finally, Mindanao Island. Outside of the Philippines, it is known from Brunei, Sabah, Sarawak, Java, Sumatra, Buru, East and West Kalimantan, and Sulawesi, at 862 –3,000 m elevation.

Ecology and conservation status.—*Myrsine avenis* is most frequently found on windswept ridgetops in forests dominated by Ericaceae and Podocarpaceae, in forests termed “mossy forest,” “montane forest” or “upper submontane forest.” The climate is extremely hostile and there is precious little commercially valuable timber on these sites. However, with increasing demands for telecommunication installations on the tops of many mountains throughout Malesia, this species may be considered threatened.

Etymology.—The specific epithet, ‘*avenis*’ refers to the secondary veins, not readily visible from either the abaxial or adaxial side of the leaf.

Common names.—“Berig” (Bisayan, Panay dialect, Madulid 1992); “Paspas” (Bukidnon, Binukid Manobo dialect, probably from the northern portion of the Kitanglad Mountain Range, Madulid 1992).

Specimens examined: **PHILIPPINES. LUZON ISLAND. Baatan Prov.:** Lamao River, Mt. Mariveles, May 1905 (stam. fl), *R. Meyer* 3114 (K, PNH). **Benguet Prov.:** Mt. Pulogloco, Sep 1921 (pist. fl, fr), *M. Ramos & G. Edaño* BS 40394 (US); Mount Santo Tomas, 26 Mar 1935 (fr), *M. S. Clemens* 51876 (A, MICH), Mar 1904 (stam. fl), *A. Elmer* 5811 (A, K, PNH, US), Jun 1904 (fr), *A. Elmer* 6539 (K, PNH, US), 3 Dec 1953 (fr), *E. Walker* 7546 (US), 28 Oct 1904 (pist. fl, fr), *R. Williams* 1346 (GH, K, NY, US); Mar 1907 (fr), *A. Elmer* 8745 (L, NY, US); *sine loc. esp.*, Mar 1916 (fr), *C. Garcia* 25507 (US); Baguio and vicinity, May 1911 (bisex. & pist. fl), *C. B. Robinson* BS 14088 (K, L, PNH, US), Mar [1907]1913 (fr), *A. Elmer* 14286 (BISH, GH, K, L, NY, US); Mt. Tonglon, Bagio, Dec 1908 (fr), *M. Merritt* FB 14153 (US). **Camarines Norte Prov.:** Vicinity of Paracale [probably near Parang], *s.d.* (fr), *S. Vidal* 1526 (L); **Camarines Sur Prov.:** Tinambak, Haribon Foundation for the Conservation of Natural Resources, Luzon, Mt. Isarog National Park, Tinambac Cawayan access trail N to Ulag Ganabo, Balagbag Kulod facing Isarog Tilhang. Ulag and vicinity, 895–2,000 m, 20 Feb 1993 (pist. fl bud), *B. Hernaez & M. Cajano* CAHUP 60019 (CAHUP), Balagbag Kulod facing Isarog Tilhang Trail to Kabagtuan, Gapugapuan and vicinity, 895–1065 m, 22 Feb 1993 (pist. fl bud), *Hernaez & M. Cajano* CAHUP 60020 (CAHUP). **Ilocos Norte Prov.:** Mt. Palimlim, *M. Ramos* BS 33285 (NY). **Laguna Prov.:** Mt. Banahao [Banajao, ca. 14°04'N, 121°29'E], Jan 1913 (fr), *M. Ramos* BS 19576 (US), Apr 1925 (fr), *M. Sulit* BS 30073 (NY); Los Baños, Mt. Makiling, Mar 1906 (ster), *A. Lober* 6140, Jun–Jul 1917 (ster), *A. Elmer* 17815 (A, K, L, NY, PNH, US), (fr), *A. Elmer* 18270 (A, BISH, K, L, NY, PNH, US), 21 Jul 1964 (stam. fl), *J. Hernaez* 867 {CAHUP 18393} (CAHUP); Peak 2, 1060 m, 10 Jun 1966 (stam. fl), *B. Hernaez* 867 {CAHUP 58864, 58865, 58866} (CAHUP), 10 Jun 1966 (stam. fl), *N. Orlido* CAHUP 17927 (CAHUP), summit, Mt. Makiling, 1,100 m, 18 Jan 1913 (fr), *F. Gates* 5196 (CAHUP, UC); Mt. Maquiling, Mar 1913 (fr), *Forestry School, UP Los Baños* FB 20145 (US). **Laguna/Quezon Prov. border:** Mt. Banaho, *s.d.* (fr), *S. Vidal* 1516bis (A). **Rizal Prov.:** Mt. Susong-Dalaga, Aug 1917 (fr), *M. Ramos & G. Edaño* BS 29282 (A, K, US); Montalban, Sep 1909 (stam. fl), *A. Lober* 12009 (A), (fr), *A. Lober* 12038 (A); Sumag, Apr 1914 (stam. fl), *A. Lober* 14097 (A); *sine loc. esp.* May 1907 (fr), *M. Ramos* BS 2650 (BISH, US). **Quezon Prov. [Tabayas]:** Dec 1993 (fr), *A. Lober* 3830; (K, PNH, US); Banahao, Feb 1906 (ster.), *A. Lober*, 6125 (K, PNH), *s.d.* (fr), *Vidal* 1516 (A, PNH); Lucuban, 1,829 m May 1907 (fr), *A. Elmer* 9351, 9352 (A, K, L, NY, PNH, US). **Mountain Prov.:** Bayninan, Banaue, Ifugao, 1,219 m, 26 Mar 1963 (pist. fl, fr), *H. C. Conklin & Buwaya* I-1023 {PNH 79612} (K, L, PNH). **MINDORO ISLAND. Oriental Mindoro Prov.:** Mt. Halcon, 862 m, 16 Feb 1948 (fr), *G. Edaño* 192 (PNH 3574) (A, L); Mt. Yagaw, S slopes, 400 m, 30 Sep 1953 (ster.), *H. Conklin* 529 {PNH 18989} (L), Mt. Yagaw, E slope, SE slope, 330 m, 28 Dec 1953 (ster), *H. Conklin* 864 {PNH 19321} (L, PNH). **NEGROS ISLAND. Negros Occidental Prov.:** SW face of Mt. Canlaon near summit crater, above Guintubdan, 31 Mar 1992 (fr), *B. Stone et al.* PPI6471 (A, BRIT, PNH), Apr 1910 (fr), *E. Merrill* BS 6998 (US). **MINDANAO ISLAND. North Cotabato Prov.:** Todaya, Mt. Apo, 1905 (fr), *R. Williams* 2603 (A).

Myrsine avenis belongs to a complex of perhaps 15 taxa, within which *Myrsine affinis* A. DC. is the name most often misapplied to it. It is probably most closely related to *Myrsine capitellata* Wallich (*non alior*), differing in much longer pedicels, greater numbers of flowers per inflorescence, and the pubescent branchlet apices.

In the Philippines, *Myrsine avenis* was frequently labelled “*Myrsine philippinensis*” by such workers as Elmer, Lober, and even Merrill on occasion. This led to much confusion as later collections were apparently matched

to those determined by these prodigious students of the Philippine flora. However, *Myrsine avenis* resembles *M. philippinensis* only in the highly visible pedicels. In addition to the pubescent branchlets of *M. avenis*, it is restricted to upper montane habitats, while *M. philippinensis* is strictly a mangrove species.

11. *Myrsine penibukana* (Philipson) Pipoly, comb. nov. (Fig. 3I). *Rapanea penibukana* Philipson, London J. Bot. 78:105. 1939. TYPE: MALAYSIA. SABAH [BRITISH NORTH BORNEO]: Mount Kinabaulu: Penibukan, flat place on ridge at 1,219 m., 18 Oct 1933 (stam. fl), J. & M. Clemens 20764 (HOLOTYPE: BM, n.v.; ISOTYPES: A*!; K!, NY*!). *The sheets at A and NY bear the number J. & M. Clemens 40764, written in pencil at the bottom of the label, but the A sheet was annotated by Philipson before publication of the species. Given that the number was not included by him as a paratype along with the other collections, and that there are several other data stricken out and partially corrected on the label, it is assumed that the A and NY sheets' number is a typographical error and that they are, isotypes.

Tree to 20 m tall. *Branchlets*: terete, 2.5–3 mm diam., sparsely ferruginous glandular-granulose, glabrescent. *Leaves*: buds minutely and sparsely ferruginous glandular-granulose, glabrescent, the margins rufous glandular-ciliate; blades thinly coriaceous, symmetric, oblanceolate, elliptic or obovate, (3.5–)7–10 cm long, (2.2–)2.5–4 cm wide, apically obtuse, basally acute, decurrent on the petiole to base, subnitid and conspicuously but not prominently pellucid punctate above, pallid and conspicuously black punctate-lineate below except prominently black punctate between submarginal vein and margin, the midrib impressed above, prominently raised below, the secondary veins inconspicuous on both sides, 9–12 pairs, the submarginal collecting vein ca. 0.5 mm from margin, marginally flat and entire; petiole marginate, flat above, 6–8 mm long, glabrous. *Staminate inflorescence*: fasciculate; peduncles forming “short shoots” (3.5–)4–12.5 mm long, 1–2.5 mm diam.; floral bracts coriaceous, oblate, 0.5–0.7 mm long, 1–1.2 mm wide, apically broadly rounded, medially prominently pellucid punctate, with hyaline, scarious, erose-fimbriate, and long white glandular-ciliate margin; pedicels obsolete to cylindric and 0.5(–0.7) mm long. *Staminate flowers*: 5-merous, chartaceous, 2.8–3 mm long; calyx cupuliform, 1.3–1.6 mm long, the tube ca. 0.1 mm, the lobes ovate or oblong, 1.2–1.5 mm long, 0.5–0.7 mm wide, apically obtuse to acutish, densely pellucid to orange punctate and punctate-lineate medially, irregular, entire, and glandular-ciliate along the margin; corolla campanulate, 2.8–3 mm long, the tube 0.5–0.7 mm long, the lobes elliptic to oblong, 2.3–2.5 mm long, 0.7–1.0 mm wide, apically obtuse, cucullate, densely and prominently pellucid punctate-lineate medially, prominently red punctate along entire margin, glandular-granulose within and on margin, the margin entire; stamens 1.8–2 mm long, the filaments completely fused to corolla tube, ca.

0.5 mm long, the anthers ovoid, 1.3–1.5 mm long, 1 mm wide, apex apiculate, base cordate, the connective prominently red punctate-lineate; pistillode vestigial, conical and hollow, ca. 0.5 mm long, or absent. *Pistillate inflorescence*: unknown. *Fruit* subglobose, 4.5–5 mm long, 3.8–4 mm diam., densely and prominently pellucid punctate-lineate.

Distribution.—Known only from the type locality, Mt. Kinabalu, Sabah, and Luzon Island, in Abra, Quezon and Rizal provinces, Philippines, at 1,000–1,200 m.

Ecology and conservation status.—*Myrsine penibukana* is a highly restricted species new to the flora of the Philippines. At this time, nothing is known of its ecology or its conservation status.

Etymology.—The specific epithet refers to the type locality, Mt. Penibukan, a part of the Mt. Kinabalu Range, in northern Sabah, on the island of Borneo, Malaysia.

Common names.—While no common names have been reported for this taxon *per se*, it is expected that “Tongog” (Bisayan-Panay dialect, and Bagobo languages) would be used for this taxon, as for all members of the genus *Myrsine*.

Specimens examined: **PHILIPPINES. LUZON ISLAND. Abra Prov.**: Mt. Posuey, Feb 1927 (fr), *M. Ramos* BS 20710 (A). **Rizal Prov.**: Jan 1913 (stam. fl), *A. Lober* 13871 (A), Feb 1913 (stam. fl), *A. Lober* 14221 (A), (stam. fl), *A. Lober* 14230 (A); sine loc. esp., May 1907 (fr), *M. Ramos* BS 2640 (L). **Quezon Prov.**[Tabayas]: Mt. Dingalan, Aug–Sep 1916 (fr), *M. Ramos & G. Edaño* BS 26612 (US). **MALAYSIA. SABAH [BRITISH NORTH BORNEO]**: Mt. Kinabalu, Penibukan, 16 Jan 1933 (stam fl), *J & M. S. Clemens* 31119 (A, BM). 8 Nov 1933 (stam. fl bud), *J & M. S. Clemens* 50295 (A, BM, NY).

Myrsine penibukana is a new record for the Philippines. Within the country, it can be confused with *M. fastigiata*. However, the erose-fimbriate floral bract margins with long white glandular cilia, the much longer short shoots, corolla lobes with red punctations along the margins and pellucid punctate-lineations medially, and red punctate-lineate anther connective of *M. penibukana* clearly distinguish it from *M. fastigiata*.

Myrsine penibukana is most closely related to another Sabah species, described by Merrill as *Rapanea multibracteata*. However, because I recognize all species of *Rapanea* as members of *Myrsine*, the following combination is necessitated:

- 11a. ***Myrsine multibracteata*** (Merrill) Pipoly, comb. nov. *Rapanea multibracteata* Merrill, J. Asia Soc. Malay 1:24. 1923. TYPE: MALAYSIA. SABAH [BRITISH NORTH BORNEO]. Sandakan, Jan 1921 (stam. fl), *M. Ramos* 1345 (HOLOTYPE: BM, n.v.; ISOTYPES: A* !, K!). *The isotype at A bears the number “*Ramos* 1354” instead of “*Ramos* 1345” as cited in the protologue. However, because it is an obviously retyped label, it is most likely that this represents a true isotype.

Myrsine multibracteata is most closely related to *M. penibukana*, because of the long, multibracteate short flowering shoots, the coriaceous, glandular-ciliate, and oblate floral bracts, 5-merous flowers with ovate to oblong calyx lobes, elliptic to oblong corolla lobes, and the coriaceous leaves. However, they may easily be distinguished by the following key:

1. Leaf buds and branchlets ferrugineous glandular-granulose; leaf blades thinly coriaceous, nitid above, conspicuously black punctate-lineate below; calyx 1.3–1.6 mm long, the lobes 1.2–1.5 mm long, 0.5–0.7 mm wide, densely pellucid to orange punctate and punctate-lineate medially, the margin irregular, entire, glandular-ciliate; corolla chartaceous, 2.8–3 mm long, the lobes cucullate, densely and prominently pellucid punctate-lineate medially, prominently red punctate; plants of montane forests 11. *M. penibukana*
1. Leaf buds and branchlets rubiginous glandular-papillate; leaf blades thickly coriaceous to cartilaginous, sordid above, densely and prominently pellucid and red punctate and punctate-lineate below; calyx 0.8–1.0 mm long, the lobes 0.6–0.8 mm long, 0.3–0.4 mm wide, sparsely pellucid punctate medially, the margin entire, glabrous; corolla membranaceous, 1.5–2 mm long, the lobes flat, sparsely pellucid punctate-lineate; plants of mangrove swamps 11a. *M. multibracteata*

At this writing, *M. multibracteata* has not been found in the Philippines. It is a characteristic element of the mangrove vegetation of Sabah.

12. ***Myrsine fastigiata*** (Elmer) Pipoly, comb. nov. (Fig. 3E, H). *Rapanea fastigiata* Elmer, Leaf. Philipp. Bot. 2:670. 1910. TYPE: PHILIPPINES. MINDANAO ISLAND. North Cotabato Prov.: [Todaya], Mt. Apo, 2000 m, Aug 1909 (stam. fl), A. Elmer 11447 (HOLOTYPE: PNH, destroyed; LECTOTYPE, here designated, GH!; ISOLECTOTYPES: A !, K, L, NY!).

Tree to 8 m tall. *Branchlets*: angulate, 2.5–4 mm diam., densely rufous papillose-tomentose, glabrescent. *Leaves*: buds densely rufous papillose tomentose, especially on adaxial petiole surface, the bud margin densely rufous ciliolate; blades coriaceous, symmetric, elliptic, oblong or rarely oblanceolate, (3–)6–7(–9) cm long, (1.5–)2–2.5 cm wide, apically acute to acuminate, the acumen with an obtuse tip, basally cuneate, decurrent on the petiole, nitid and smooth above, scrobiculate with obscure black punctations and punctate-lineations below, midrib immersed above, prominently raised below, the secondary veins 15–20, prominulous above and below (with magnification), the submarginal collecting vein ca. 1 mm from margin, with the margin entire, revolute; petiole marginate, 5–8 mm long, almost flat above, glabrous at maturity. *Staminate inflorescence*: fasciculate, 4–9-flowered; peduncle 3.5–4.0 mm long, 1–2.5 mm diam.; floral bracts chartaceous, widely ovate to suborbicular, 2.0–2.5 mm long and wide, apically broadly rounded, cucullate, densely and prominently black punctate and punctate-lineate medially, the margin scarious, hyaline, densely

rufous glandular-ciliolate, entire; pedicels obsolete or cylindric to 2 mm long. *Staminate flowers*: pale green; 5–6-merous, chartaceous, 2.8–3.3 mm long; calyx cotyliform, 1–1.5 mm long, the tube 0.3–0.5 mm long, the lobes ovate to suborbicular, 0.7–1.0 mm long, 0.7–1.0 mm wide, apically rounded to obtuse, densely and prominently black punctate medially, the hyaline, erose apically, and densely glandular-ciliolate; corolla subrotate, 2.5–3 mm long, the tube 0.8–1.0 mm long, the lobes narrowly ovate, 2–2.2 mm long, 0.8–1.3 mm wide, apically subacuminate, glabrous, densely and prominently black punctate and punctate-lineate medially, with the margin entire, densely glandular-ciliate throughout its length; stamens 2.2–2.5 mm long, the filaments 1.3–1.5 mm long, basally fused to the corolla tube ca. 1 mm, the apically free portion ca. 0.5 mm, the anther ovate, 0.8–1 mm long, 0.3–0.5 mm wide, the apex apiculate, the base cordate, dehiscent by introrse, wide longitudinal slits, the connective epunctate; pistillode conic, ca. 1 mm long, 0.5 mm wide, hollow, the stigma and style not differentiated. *Bisexual flowers*: like staminate but 2.5–3 mm long, calyx 1.2–1.4 mm long, the tube ca. 0.2 mm long, the lobes subdeltate 1–1.2 mm long and wide; corolla 3–3.5 mm long, the tube ca. 0.5 mm long, the lobes narrowly ovate to lanceolate, 2.5–3 mm long, 1.3–1.5 mm wide; stamens 2.2–2.5 mm long, the filaments 0.5 mm long, entirely fused to corolla tube, the anthers oblong to ovate, 1.8–2 mm long, 0.4–0.6 mm wide; pistil subglobose, slightly costate, 1.3–1.6 mm long, 0.8–1.3 mm diam., the placenta globose, apically apiculate, ovules 3, deeply immersed in placenta, stigma conical, with a stylopodic base, slightly lobed. *Pistillate flowers*: like staminate but 3–3.5 mm long; calyx 1.3–1.5 mm long, the tube 0.2–0.3 mm long, the lobes widely ovate, 1.1–1.3 mm long and wide; corolla 3–3.5 mm long, the tube 0.3–0.5 mm long, the lobes ovate, 2.5–3 mm long, 0.8–1 mm wide, apically somewhat acuminate; staminodes 2.3–2.5 mm long, the filaments 0.5 mm long, entirely fused to corolla tube, the antherodes lanceolate, 1–1.5 mm long, the apically acute, basally sagittate, without pollen; pistil 2.3–2.5 mm long, the ovary subglobose, 2.2–2.3 mm long and diam., the stigma conic, with a stylopodic base, slightly 4-lobed, the placenta subglobose, the ovules 6, inserted and exposed in one series near placenta. *Fruit* subglobose, 2.5–3 mm long and in diam., prominently orange punctate and punctate-lineate.

Distribution.—Endemic to the Philippines, from the Mountain Province of Luzon southward through Camarines and Leyte to Bukidnon Province of Mindanao, at 2,000–2,500 m elevation

Ecology and conservation status.—*Myrsine fastigiata* is a conspicuous element of short, dense stands of upper montane moist forests. These few remaining forests are found on a very limited number of mountains in the country, and therefore, the species is considered endangered.

Etymology.—The epithet ‘fastigiata’ refers to the clustered, erect branches of the tree. This is more accurately described by its architectural model, “Rauh’s Model “ (*sensu* Halle et al. 1978). Trees exhibiting Rauh’s Model are characterized by their rhythmically growing, readily distinguishable trunks, which develop tiers of branches morphogenetically identical to those trunks. All branches are orthotropic and monopodial, with lateral (“axillary”) inflorescences that do not affect shoot development. In *Myrsine*, like other Myrsinaceae, branching is sylleptic, easily recognized by the absence of basal bud-scales and by the elongate hypopodium. Therefore, given room to grow freely, and without experiencing reiteration phenomena, all species of *Myrsine* could indeed appear “fastigiata” in the sense the term is used here.

Common names.—“Supak” (Igorot). Because this species has heretofore been confused with *Myrsine avenis*, it is probable that other names, such as “Berig” (Bisayan-Panay dialect) and “Paspas” (Bukidnon-Binukid Manobo dialect) will also apply to it.

Specimens examined. **LUZON ISLAND.** **Bataan Prov.:** Mt. Mariveles, upper Lamao River, 1,060 m, 23 Mar 1904 (fr), *R. Williams* 750 (NY, US), Mar 1905 (bud), *E. Merrill* BS 3954 (NY, US). **Benguet Prov.:** Atok Municipality, Mt. Pauai, Apr–Jun 1918 (bisex. fl), *J. Santos* BS 31782 (A, K, PNH, US), (pist. fl, fr), *J. Santos* BS 31995 (A, K, PNH, US); Mt. Paua, 2,380 m, 15 Apr 1994 (fr), *L. Co* 4135 (BRIT, CAHUP, PUH), “Heights in the Oaks,” 2,134 m, Jul 1907 (fr), *E. A. Mearns* 4270 (L); *sine loc. esp.* Dec 1926 (fr), *M. Clemens* 17218 (NY); Baguio, Mar 1907 (fr), *A. Elmer* 8597 (A, K, US), (fr), *A. Elmer* 8807 (A, K, L, US); Mt. Santo Tomas, beyond jeep track, 1 Jul 1958 (pist. fl, fr), *J. Sinclair & G. Edaño* 9800 (L, PNH, SING); Mt. Singakalsa, Mar 1931 (fr), *E. Quisumbing & M. Sulit* BS 82441 (A). **Camarines del Sur Prov.:** Paracale, *s.d.* (fr), *S. Vidal* 1525“A” (A). **Mountain Prov. [Bontoc]:** *s.d.*, (fr), *S. Vidal* 1525 (K); Mt. Catua, Bontoc, Mar 1920 (bisex. fl), *M. Ramos & G. Edaño* BS 37982 (A, L, US); Mt. Pulog, 10 Mar 1961 (stam. fl), *M. Steiner* 1921 (L), Mt. Pulog, 16°36'N, 120°54'E, 2,350–2,450 m, 22 Jan 1968 (pist. fl, fr), *M. Jacobs* 7039 (A, K, L, LBC, PNH); W slopes of Mt. Pulog, Mar 1948 (bisexual fl), *M. Celestino et al.* 0–268 (PNH 4330) (A); Mt. Pulog, Jan 1909 (bud), *H. Curran et al.* FB 18038 (US), (pist. fl), *H. Curran et al.* FB 18139 (BISH); Mt. Nañgaoto, Km 62 below rod, 2,500 m, 3 Feb 1948 (stam. fl), *M. Sulit* 2343 (PNH 7687) (A); 2,400 m, 24 Jan 1948 (stam. fl), *M. Sulit* 2197 (PNH 7485), (A, L); Mt. Tabayoc, 16°42'N, 120°53'E, 2,240 m, 18 Feb 1968 (pist. fl, fr), *M. Jacobs* 7532 (A, K, L, LBC PNH), 2,000–2,100 m, 19 Feb 1968 (stam. fl), *M. Jacobs* 7564 (A, K, L, LBC, PNH). **Ifugao Prov.:** Mt. Polis, Feb 1913 (stam. fl), *R. M^c Gregor* BS 19646, (K, L, PNH, US), BS 19833 (K, L, PNH, US), Mt. Polis, 16°59.2'N, 121°02.4'E, 1,880 m, 18 Apr 1993 (ster.), *L. Co* 3812 (A, CAHUP, CANB, K, L, PUH, US). **Zambales Prov.:** Santa Cruz, *S. Vidal* 1517 (A, L). **LEYTE ISLAND.** **Leyte Prov.:** Mt. Suiro, N slope, 900 m, 5 May 1954 (fr), *M. Sulit* 5450 [PNH 21617 (L, PNH)]. **MINDANAO ISLAND.** **Bukidnon Prov.:** Mt. Lipa, Jun–Jul 1920 (fr), *M. Ramos & G. Edaño* BS 38494 (K, PNH, US).

Myrsine fastigiata was placed into synonymy under *Myrsine avenis* by Merrill (1923), but can be separated from it by the tomentum of the branchlets (rufous papillose-tomentose vs. rufous tomentose with rufous sessile scales), longer petioles, subsessile, fasciculate inflorescences, and much

shorter pedicels. Its habitat is similar to that of *Myrsine avenis* but label data imply that *M. fastigiata* occurs in more sheltered thickets of those forests.

13. ***Myrsine aralioides*** (Philipson) Pipoly, comb. nov. (**Fig. 3A, B**). *Rapanea aralioides* Philipson, London J. Bot. 78:104. 1939. TYPE: MALAYSIA. SABAH [BRITISH NORTH BORNEO]. Mount Kinabalu, Penibukan, at head of the divide of Dahombong Creek, at 1,524 M, 11 Oct 1933 (pist. fl, fr), J. & M. S. Clemens 40664 (HOLOTYPE: BM, n.v.; ISOTYPES: A!, K!, L!, NY!).

Tree to 7 m tall. *Branchlets*: terete, 7–10 mm diam., drying sulcate, sparsely covered with minute translucent or rubiginous glandular lepidote scales, glabrescent. *Leaves*: buds densely covered by minute translucent or rubiginous glandular lepidote scales, the margin sparsely rubiginous glandular ciliate basally, glabrescent; blades cartilaginous to thickly coriaceous, symmetric, elliptic to oblanceolate or obovate, 8.5–15(–21) cm long, 3.5–5(–8.5) cm wide, apically obtuse, rounded or acutish to an obtuse tip, basally rounded and often abruptly tapering, decurrent on the petiole to base, prominently punctate and scrobiculate and subnitid above, densely and prominently red punctate and black lineate-punctate below, the midrib prominently raised above and below, the secondary veins 20–25 pairs, the submarginal collecting vein inconspicuous, ca. 1.5 mm from margin, the margin entire, revolute; petiole amply marginate and canaliculate, 5–10 mm long, glabrous at maturity. *Staminate inflorescence*: unknown. *Bisexual inflorescence*: a 6–9-flowered umbel; peduncle 3.5–5 mm long, (3–)3.5–4 mm diam.; floral bracts coriaceous, oblate, 1.2–1.5 mm long, 1.5–2 mm wide, apically acute, cucullate, inconspicuously pellucid punctate, the margin entire, densely villous-glandular-ciliate; pedicels cylindrical, 2.6–4 mm long. *Bisexual flowers*: 5-merous, 3.3–3.5 mm long; calyx cotyliform, 1.5–2 mm long, the tube to 0.5 mm, the lobes deltate, 1–1.5 mm long, 1–1.4 mm wide, apically acute, medially transversely rugose, densely and prominently black punctate marginally and black punctate-lineate medially, the effect rendering the lobe verruculose, the margin entire, glandular-ciliolate; corolla 3.3–3.5 mm long, the tube ca. 0.2 mm long, the lobes elliptic, 3.1–3.3 mm long, 1–1.2 mm wide, apically acute, densely black punctate-lineate apically and toward the margin, densely glandular-granulose apically within and on the margin itself without; stamens 2.5–2.7 mm long, the filament ca. 0.2 mm long, the anther lanceolate, 2.3–2.5 mm long, ca. 1 mm wide, apically acute, basally deeply cordate, the connective sparsely and minutely but prominently black punctate; pistil obconic, 1–1.4 mm long, the ovary ca. 1 mm long, the style and sigma morchelliform, ca. 0.3 mm long, the ovules 2–3, uniseriate. *Fruit* globose, 3–5 mm long and in diam., densely and prominently red punctate. *Pistillate inflorescence*: a 12–15-flowered umbel; peduncle a “short shoot” 8–10

mm long, 2–3 mm diam.; pedicels 2.6–4.0 mm long; floral bracts chartaceous, ovate, 1.5–1.7 mm long, 0.6–0.8 mm wide, apically acute, densely and prominently punctate medially, the margin entire, densely glandular-ciliate. *Pistillate flowers*: 5–6-merous, like bisexual but calyx 1.3–1.5 mm long, the tube ca. 0.2 mm long, the lobes ovate, 1.1–1.3 mm long, 0.6–0.8 mm wide; corolla 2.2–2.5 mm long, the tube 0.3 mm long, the lobes 2.1–2.2 mm long; staminodes resembling stamens but reduced in size, 1.2–1.4 mm long, the filaments entirely adnate to the corolla tube, ca. 0.3 mm long, the apical free portion ca. 0.1 mm long, the antherodes 0.6–0.8 mm long, 0.3–0.4 mm wide, apically acute, devoid of pollen; pistil conic, 2–2.2 mm long, the ovary ovoid 1–1.2 mm long, 0.8–1 mm diam., the stigma translucent, carnose, 4-lobed, the placenta depressed-globose, ovules 4–6, immersed in the placenta. *Fruit* like bisexual fruit.

Distribution.—In the Philippines, *Myrsine aralioides* is known only from the Island of Mindanao (Surigao del Norte Province) and the Island of Palawan, Palawan Province, at 150–200 m elevation. Outside the Philippines, the species is well known from Marai Parai and Penibukan, of the Kinabalu Mountain Chain in northern Sabah, Malaysia, at 1,524 m elevation.

Ecology and conservation status.—*Myrsine aralioides* is an exceedingly rare taxon, especially in the Philippines, and as such should be considered endangered. Given its distribution, it may be an ultramafic specialist. Unfortunately, because it is known from mostly historical collections, with few modern data, its ecology is in further need of study.

Etymology.—The specific epithet refers to the ramigerous and ramuligerous umbels, especially conspicuous when in fruit, which are reminiscent of *Schefflera* (Araliaceae) species when viewed from afar.

Common names.—"Lanito" (Bisayan-Davao del Sur).

Specimen examined. **PHILIPPINES**. MINDANAO ISLAND. Davao Oriental Prov.: South Basiao Mati [ca. 06°57'N, 126°13'E], along Biga Creek, 8 May 1929 (fr), L. Aguilar 53 {PNH 31044} (NY). Surigao [del Sur ?] Prov.: Jun 1919 (fr), M. Ramos & J. Pasgasio BS 34674 (A). PALAWAN ISLAND. Palawan Prov.: Mt. Bloomfield Sabang, Aug–Sep 1986 (fr) E. Reynoso & J. Proctor *et al.* 489 (BISH, L, PNH); Mt. Bloomfield, WNW to W face, near chromite mine, [ca. 10°12'N, 118°52'E], 150–200 m, 6 May 1984 (fr), C. Ridsdale *et al.* SMHI 1623 (L, PNH). **MALAYSIA**. SABAH [BRITISH NORTH BORNEO]: Ranau District: along E Mesilau River between Mt. Kinabalu golf course site and Mesilau Cave 06°03'N, 116°36'W. 1,700–1,900 m, 20 Dec 1983 (fr), J. Beaman 7992 (GH, K, L, MSC, UKMS); Pig Hill, 2,134m, 18 Feb 1964 (pist. fl, fr), W. Chew & E. Corner RSBN 4370 (K, L); Upper Kinabalu, 1,829–4,115 m, 7 Jan 1931 (fr), J. & M. Clemens 27801 (K, L, NY), 3,350 m, 7 Dec 1933 (stam. fl), J. & M. Clemens 50807 (NY); Penibukan, 1,219–1,524 m, 16 Jan 1933 (fr), J. & M. Clemens 30989 (A, L, NY); Ranau District, Marai Parai, 1,524 m, 30 Mar 1933 (fr), J. & M. Clemens 32346 (A, L, NY), 10 Apr 1933 (fr), J. & M. Clemens 32612 (A, L, NY), 1,524–1,829 m, 17 Sep 1965 (fr), A. Kanis 53996 (L, SAN); Small valley N of Carson's Camp, 2,700–2,900 m, 15 Jan 1989 (ster.), M. Hotta 3899 (L).

In the Philippines, *Myrsine aralioides* can be most often confused with

M. glandulosa, but is easily distinguished by its thick, sulcate branchlets, the branchlet and leaf bud vestiture of minute translucent or rubiginous lepidote scales, the marginate and canaliculate petioles, larger thickly coriaceous to cartilaginous leaf blades, and the deltate calyx lobes. There may be an as yet undescribed, more closely related taxon from upper montane forest on the Selangor/Pahang Genting Highlands access road in Malaya, which differs primarily in having longer petioles, much longer, angulate pedicels, and larger fruits.

14. *Myrsine glandulosa* (Elmer) Pipoly, comb. nov. (Fig. 3C, D). *Rapanea glandulosa* Elmer, Leaflet Philipp. Bot. 8:2784. 1915. TYPE: PHILIPPINES. MINDANAO ISLAND. Agusan Prov.: Cabadbaran (Mt. Urdaneta), 1,524 m., Oct 1912 (fr), A. Elmer 14148 (HOLOTYPE: PNH, destroyed; LECTOTYPE, here designated: A!; ISOLECTOTYPES: BISH!, GH!, L!, K! NY!).

Epiphytic shrub to tree to 3.5 m tall. Branchlets longitudinally ridged to angulate, 3–3.5 mm diam., densely rufous glandular stellate tomentose at first, early glabrescent. *Leaves*: buds densely appressed rufous glandular stellate and dendroid-tomentose, the margins long translucent ciliate, glabrescent; blades coriaceous, obovate, oblong or oblanceolate, (4–)5–7(–9.5) cm long, (1.6–)2–2.8 cm wide, the apex obtuse or rarely, subacuminate and ending in an obtuse tip, the base cuneate, decurrent on the petiole for 3/4 its length, nitid, densely and prominently translucent punctate above and below, midrib raised for its entire length above to petiole base, prominently raised below, the secondary veins 6–9(–15) pairs, somewhat prominulous above and below, the submarginal collecting vein ca. 1 mm from margin, the margin entire, revolute, with numerous prominent pellucid punctations along its length below; petiole marginate, the midrib prominently raised above, 3–5 mm long, glabrous. *Staminate inflorescence*: unknown. *Pistillate inflorescence*: umbellate, 3–12-flowered; peduncle 2–6 mm long, 1–2 mm diam.; pedicels angulate, 3–6 mm long, densely and prominently black punctate-lineate; floral bracts chartaceous, widely oblate, 0.3–0.5 mm long, 0.8–1.1 mm wide, apex broadly rounded, densely and prominently brown punctate, the margin minutely glandular ciliate. *Pistillate flowers*: unknown. Fruiting calyx 4-merous, chartaceous, unequally divided, 0.6–0.9 mm long, the tube ca. 0.1 mm long, the lobes very widely ovate, 0.5–0.7 mm long, 0.6–8 mm wide, apically obtuse, sparingly but prominently black punctate, the margin irregular, entire except minutely erose apically, glabrous. *Fruit* globose, 3.5–4.5 mm long and in diam., densely and prominently black punctate, the remnant stigma base stylopodic.

Distribution.—*Myrsine glandulosa* is apparently endemic to the Philippines, thus far known only from southern Mindanao and nearby Negros Oriental, at 1,350–2,242 m elevation.

Ecology and conservation status.—This species is poorly known, and has been found only in submontane forest.

Etymology.—The specific epithet refers to the extremely prominent pelucid punctations of the adaxial and abaxial surfaces of the leaf blades.

Common name.—“Nagas” (Magobo language, Madulid 1992).

Specimens examined. **PHILIPPINES.** **NEGROS ISLAND.** **Negros Occidental Prov.:** SW face of Mt. Canlaon, above Guintubdan Forest Hut, 1,350 m, 29 Mar 1992 (fr), *B. Stone et al.* PPI6643 (A, BO, BRIT, K, L, PNH, US). **Negros Oriental Prov.:** Dumaguete, Cuernos Mts., 1,680 m, May 1908 (fr), *A. Elmer* 9992 (A, K, NY, PNH, US), (fr), *A. Elmer* 10186 (A, K, L, PNH, US). **LEYTE ISLAND.** **Leyte Prov.:** *sine loc. esp.*, 5 Jun 1914 (fr), *C. A. Wenzel* 945 (A), 15 Aug 1914 (fr), *C. A. Wenzel* 1063 (A, GH). **MINDANAO ISLAND.** **Bukidnon Prov.:** Kaatoan, Malaybalay, 11 Oct 1953 (stam. fl), *B.B. Britton* 441 {PNH 19666} (L, PNH); *sine loco esp.*, Jul–Aug 1914 (fr), *L. Escritor* BS 21404 (L, NY). **Davao del Sur Prov.:** Davao, Aug 1933, *R. Kanehira* 2672 (NY); Mt. McKinley, 2,000 m, 24 Aug 1946 (ster.), *G. Edaño* 757 {PNH 1013} (A, L, PNH) 7,400 ft, 13 Sep 1946 (ster), *G. Edaño* 987 {PNH 976} (A, L, PNH), 1002 {PNH 1052} (A, K, L), (pist. fl, fr), 999 {PNH 979} (A); 995 {PNH 994} (pist. fl, fr) 895 {PNH 987}, 2466 m, 25 Sep 1946 (fr), *G. Edaño* 1059 {PNH 1568} (A). **South Cotabato Prov.:** Mt. Matutum, Apr 1932 (ster.), *M. Ramos & G. Edaño* BS 85015 (A), Mt. Matutum 2,242 m, 15 Apr 1992 (fr), *F. Gaerlan et al.* PPI 5361 (A, BO, BRIT, K, L, PNH); Klaja Hill, Barrio Konel, 13 Sep 1950 (pist. bud), *P. Añonuevo* 297 {PNH 13598} (A, L, PNH).

Myrsine glandulosa may easily be confused with *M. aralioides* in the Philippines, but differs by the thinner branchlets, less coriaceous leaves, prominent leaf punctations, red-papillose tomentum of the leaf buds, raised leaf midrib decurrent to the petiole base, longer petioles, thin peduncle and smaller sepals.

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NUMERICAL LIST OF TAXA

- | | |
|---|--|
| 1. <i>Myrsine medeciloae</i> Pipoly | 9. <i>Myrsine philippinensis</i> A. DC. |
| 2. <i>Myrsine apoensis</i> (Elmer) Pipoly | 10. <i>Myrsine arenis</i> (Blume) A. DC. |
| 3. <i>Myrsine amorosoana</i> Pipoly | 11. <i>Myrsine penibukana</i> (Philipson) |
| 4. <i>Myrsine oblongibacca</i> (Merrill) Pipoly | Pipoly |
| 5. <i>Myrsine cruciata</i> (Philipson) Pipoly | 11a. <i>Myrsine multibracteata</i> (Merrill) |
| 6. <i>Myrsine densiflora</i> Scheffer | Pipoly |
| 7. <i>Myrsine peregrina</i> (Mez) Pipoly | 12. <i>Myrsine fastigiata</i> (Elmer) Pipoly |
| 8. <i>Myrsine mindanaensis</i> (Elmer) | 13. <i>Myrsine aralioides</i> (Philipson) Pipoly |
| Pipoly | 14. <i>Myrsine glandulosa</i> (Elmer) Pipoly |

LIST OF EXSICCATAE

The figures in parentheses refer to the numbers from the numerical list of taxa. Collection numbers in **boldface** type indicate type specimens. Collection numbers before [] brackets indicate field collection numbers; numbers in brackets indicate herbarium sheet numbers. Both are given because it appears that some duplicates have one number or the other, or both on the mounted specimen. BS indicates herbarium numbers in the Philippine Bureau of Science series, FB indicates the herbarium numbers in the Forestry Bureau Series, and PNH indicates herbarium numbers in the Philippine National Herbarium Series. Other letters indicate herbarium acronyms, except for SMHI, which is a series from the Hillebrand Expedition to Palawan, a joint project of K, L, and PNH, and PPI, a series from the Philippine Plant Inventory, a joint project co-sponsored by BRIT and PNH.

- Agaceta, E. 6 [LBC 917] (9)
 Aguilar, L. 53 [PNH 31044] (13)
 Ahern, G. FB 444 (6)
 Añonuevo, P. 297 [PNH 13598] (14)
 Argent, G. & E. Reynoso 89112 (3); 89113 (3)
 Barbon, E. et al. PPI 2267 (9); PPI 6094 (6); PPI 8223 (3); PPI 8601 (8); PPI 8845 (3)
 Beaman, J. 7992 (13)
 Britton, B.B. PNH 19666 (14); 421 [PNH 19646] (7); 441 [PNH 19666] (14)
 Celestino, M. et al. 0-268 [PNH 4330] (12)
 Chew, W. & E. Corner RSNB 4370; RSNB 4372 (5); RSNB 4493 (5)
 Clemens, J. & M.; 20764 (11); 27801 (13); 28941 (5); 30258 (5); 30989 (13); 31119 (11); 32346 (13); 32378 (5); 32612 (13); 40664 (13); 50295 (11); 50807 (13)
 Clemens, M. 917 (7); 9332 (9); 17218 (12); 51876 (10)
 Co, L. 3073 (9); 3125 (8); 3649 (2); 3812 (12); 4135 (12)
 Conklin, H. 529 [PNH 18989] (10); 864 [PNH 19321] (10)
 Conklin, H. & Buwaya I-1023 [PNH 79612] (10)
 Coode, M. et al. 5635 (3); 5765 (3)
 Cuming, H. 868 (8); 1601 (9)
 Curran, H. & M. Merritt BS 8072 (1)
 Curran, H. et al. FB 18139 (12)
 Dransfield, J. SMHI 1292 (5)
 Edaño, G. 192 [PNH 3574] (10); 630 [BS 76225] (3); 757 [PNH 1013] (14); 821 [PNH 1032] (2); 895 [PNH 987] (14); 984 [PNH 1048] (2); 987 [PNH 976] (14); 995 [PNH 994] (14); 999 [PNH 979] (14); 1002 [PNH 1052] (14); 1051 [PNH 1564] (7); 1059 [PNH 1568] (14); 1090 [PNH 1595] (7); 1095 [PNH 1568] (14); 1232 [PNH 1412] (7); 1266 [PNH 1382] (2); 1267 [PNH 1383] (2); 1445 [PNH 1557] (7); 1535 [PNH 1553] (7); 1536 [PNH 1540] (7); 8195 [PNH 22003] (3); BS 29386 (4); BS 76198 (3); BS 76268 (3); BS 77034 (4); BS 77079 (3); BS 78357 (4); BS 78412 (4); BS 78424 (4); BS 78533 (3); PNH 1540 (7); PNH 1553 (7); PNH 11565 (7); PNH 21960 (3)
 Elmer, A. 5811 (10); 6539 (10); 8597 (12); 8745 (10); 8807 (12); 9351 (10); 9352 (10); 9992 (14); 10186 (14); 10629 (2); 11332 (8); 11445 (7); 11447 (12); 11456 (7); 11820 (8); 12295 (9); 14148 (14); 14286 (10); 17815 (10); 18270 (10)
 Escritor, L. BS 21404 (14)
 Fernando, E. 1003 (6)
 Forestry School, UP Los Baños FB 20145 (10)
 Gaerlan, F. et al. PPI 3476 (6); PPI 5361 (7); PPI 5361 (14); PPI 10949 (7)
 Gammill, J. FB 272 (9); FB 276 (9); FB 301 (9)
 Garcia, C. 25507 (10)
 Gates, F. 5196 (10)
 Gideon, O. LAE 76035 (6)
 Haenke, T. 440 (3); 447 (3); 472 (3)
 Hartley, T. 11955 (6)
 Hatusima, S. & M. Sato 29059 [PNH 111132] (6)
 Hernaez, B. 867 [CAHUP 58864, 58865, 58866] (10); 2038 [CAHUP 60561, 60562, 60563, 60564] (3); 3043 (3)
 Hernaez, B. & M. Cajano CAHUP 57282 (3); CAHUP 57283 (3); CAHUP 57284 (3); CAHUP 60019 (10); CAHUP 60020 (10); CAHUP 60892 (8); CAHUP 60893 (8); CAHUP 60894 (8)
 Hosakawa, T. 8560 (7)

- Hotta, M. 3899 (13)
 Iwatsuki, K. 719 (1)
 Jacoban, S. 20 [LBC 966] (9)
 Jacobs, M. 7039 [PNH 103962] (12); 7227 [PNH 103861] (3); 7274 [PNH 103905] (3); 7333 [PNH 103962] (3); 7488 [PNH 104120] (3); 7532 (12); 7564 (12)
 Kaneira, R. s.n. (8)
 Kanis, A. 53996 (13)
 Kerenga, K. et al. LAE 77490 (6)
 Kondo, Y. & G. Edaño 113 [PNH 36799, PNH 36817] (9)
 Kostermans, A. & Soegeng 311 (6)
 Lagunsad, D. 758 (8); 870 (7) 916 (8); 961 (7)
 Lam, H. 3258 (6); 3373 (6); 3420 (6)
 Lit, I. IL 84-001 [CAHUP 40296] (3)
 Loher, A. 3830 (10); 6125 (10); 6128 (3); 6140 (10); 12009 (10); 12038 (10); 13871 (11); 14097 (10); 14221 (11); 14230 (11); 18270 (10)
 Mandia, E. 421 (3); Mandia, E. 555 (7)
 Martelino, A. & G. Edaño BS 35612 (6); BS 35682 (7)
 M^cGregor, R BS 49833 (7); BS 19646 (12); BS 19833 (12)
 Mearns, M. & W. Hutchinson FB 4573 (7)
 Mendoza, D. PNH 91353 (7)
 Merrill, E. 1206 (9); 3954 (12); 5734 (3); 5735 (3); BS 6998 (10)
 Merritt, M. BS 4449 (3); FB 14153 (10)
 Meyer, R. BS 3114 (1); 3114 (10)
 Millar, A. & J. Vandenberg NGF 40880 (6)
 Nedi, X 665 (6)
 Orantia, L. LBC 3481 (9)
 Orlido, N. CAHUP 17927 (10)
 Pancho, J. 2587 [PNH 34613] (7)
 Piper, C. BS 237 (6)
 Pipoly, J. et al. 19551 (3); 19555 (3); PPI 16584 (7); PPI 16610 (3); PPI 16647 (3); PPI 16684 (3); PPI 16871 (3)
 Podzorski, A. SMHI 2125 [PNH 159319] (5); SMHI 2130 [PNH 158938] (5)
 Quisumbing, E. & M. Sulit BS 82441 (12)
 Ramos, M. s.n. (6); 1345 (11a); BS 1524 (3); BS 1525 (3); BS 1961 (3); BS 2640 (11); BS 2650 (10); BS 5050 (5); BS 7623 (5); BS 19576 (10); BS 20710 (11); BS 22009 (3); BS 23512 (3); BS 23616 (3); BS 32757 (1); BS 33243 (1); BS 33256 (4); BS 33311 (4); BS 41559 (8); BS 77079 (4); BS 80268 (7)
 Ramos, M. & G. Edaño BS 26397 (7); BS 26418 (4); BS 26548 (4); BS 26577 (3); BS 26612 (11); BS 28758 (3); BS 29282 (10); BS 29386 (3); BS 34625 (6); BS 37982 (12); BS 38494 (12); BS 38528 (3); BS 38918 (3); BS 40394 (10); BS 40712 (7); BS 44936 (3); BS 45602 (3); BS 85015 (14); BS 85048 (7)
 Ramos, M. & J. Pasgasio BS 34674 (13); BS 34755 (8); BS 34755 (6); BS 35194 (4)
 Reynoso, E. et al. 489 (13); PPI 1087 (6)
 Ridsdale, C. SMHI 225 [PNH 157145] (5); SMHI 1623 (13); SMHI 1732 A (5); SMHI 1741 [PNH 159486] (5); 1084 [PNH 162204] (6)
 Ridsdale, C. et al. 1140 (6); 1703 (3)
 Robbins, R. s.n. (3)
 Robinson, C. B. BS 14088 (10)
 Rodulfa, E. EVR-7 [LBC 3792] (9)
 Salvoza, F. 1057 [PNH 3715] (9)

- Santos, J. BS 31782 (12); BS 31995 (12)
Sinclair, J. & G. Edaño 9800 (12)
Steiner, M. 1921 (12)
Stern, W. & P. Rojo 2299 [PNH 92363] (7)
Stone, B. et al. PPI 6471 (10); PPI 6643 (14); PPI 6906 (3)
Sulit, M. 2197 [PNH 7485] (12); 2343 [PNH 7687] (12); 3383 [PNH 10054] (7);
3467 [PNH 10125] (7); 3630 [PNH 11769] (9); 5450 [PNH 21617] (12); BS 30073
(10); PNH 11800 (9)
Teysmann, J. 7471 (6)
Univ. San Carlos 586 (2)
Vidal, S. 1516 (9); 1516 bis (10); 1517 (12); 1525 (12); 1525 A (12); 1526 (10); 3156
(9); 3183 (9)
Walker, E. 7546 (10)
Warburg, O. 21830 (6)
Wenzel, C. A. 945 (14); 1063 (14); 1368 (9)
Williams, R. 750 (12); 1346 (10); 2603 (10)
Zippelius, A. s.n. (6)
Zollinger, H. 883 (10)

MORPHOLOGY OF *PENNISETUM ORIENTALE* (POACEAE: PANICEAE)

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ABSTRACT

Pennisetum orientale Rich., a polymorphic species, is potentially important as an ornamental and as a valuable source for germplasm in forage crop improvement programs. Unfortunately little information is available on the diversity within U.S. collections. This investigation was initiated to provide an extensive morphological analysis of each of eleven *P. orientale* accessions and to characterize the germplasm. Cytological studies revealed that all accessions were tetraploids ($2n=36$) and that the method of reproduction being sexual or aposporous apomicts. Based on plant heights, leaf blade lengths and widths, inflorescence density, and growth habit in College Station (with a latitude of 31.5°), Texas, the accessions 269961, 330717, 271595, 433, and Cowboy appeared to have the best forage potential. However, this has yet to be supported by studies on nutritional value. There were also some distinct taxonomic features such as the longest ligule length in PI 315867; central spikelet length in PI's 215600 and 315867 which was significantly longer than all the other accessions. Furthermore, long anthers and filaments were observed in PI's 330717 and 315867. Additional germplasm acquisitions from non-represented areas could expand genetic diversity in the germplasm collection.

RESUMEN

Pennisetum orientale Rich. es una especie polimórfica que tiene importancia potencial como planta ornamental y como fuente valiosa de germoplasma en los programas de mejora de forrajes. Desgraciadamente hay poca información disponible sobre la diversidad en las colecciones estadounidenses. Esta investigación se inició para realizar un análisis morfológico amplio de cada una de once adquisiciones de *P. orientale* y para caracterizar el germoplasma.

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Los estudios citológicos revelaron que todas las muestras eran tetraploides ($2n=36$) y que el método de reproducción es sexual o apomixis apospórica. Basándose en la altura de las plantas, longitud y anchura de la lámina de la hoja, densidad de la inflorescencia y hábito de crecimiento en la College Station (con una latitud 31.5°), Texas, las muestras 269961, 330717, 271595, 433, y Cowboy parecen tener el mejor potencial forrajero. Sin embargo ésto aún no ha sido comprobado con estudios del valor nutritivo. También se encontraron algunas características taxonómicas diferentes, tales como la mayor longitud de la lígula en PI 315867, longitud de la espiguilla central en PI's 215600 y 315867 que era significativamente más larga que en todas las otras muestras. Además se observaron filamentos y anteras largos en PI's 330717 y 315867. Muestras adicionales de germoplasma de áreas no representadas podrían ampliar la diversidad genética de la colección de germoplasma.

The genus *Pennisetum* is classified in the tribe *Paniceae*. Within this tribe Clayton and Renvoize (1982) placed *Pennisetum* in the *Cenchrinae* Dumort, a subtribe characterized by the presence of bristles and with the disarticulation below those bristles. Thirteen genera, including *Pennisetum*, are presently included in this subtribe. *Pennisetum*, with about 90 species, is the largest genus of the *Cenchrinae*.

Several *Pennisetum* species, in the tertiary gene pool of pearl millet [*P. glaucum* (L.) R.Br.] are partially or completely apomictic (Jauhar 1981). *Pennisetum orientale* L.C. Rich. is a polymorphic species in this gene pool consisting of different cytological races. This species, considered by Stewart (1945) as a Mediterranean grass, is distributed from 600–2,700 m elevation in the western Himalayas of India westward through Asia Minor and N. Africa to Morocco.

The cultivar, "Cowboy" (*Pennisetum orientale*) released in Texas, has been reported to be more winterhardy (Hussey et al. 1989) than buffelgrass [*Pennisetum ciliare* (L.) Link] suggesting that *P. orientale* could be a valuable source for germplasm in forage improvement programs. Several interspecific hybrids have been recovered between *P. orientale* and *P. ciliare*.

Any discussion of the morphology of *P. orientale* must also address apomixis because this taxon is believed to consist primarily of obligate apomictic accessions (Chatterji & Timothy 1969; Choda and Sharma 1981). Therefore any interpretation of the results must be viewed with the understanding of the effects of apomixis on grass morphology. The effects are that there is less morphological variability within populations. Apomixis, probably best defined as "nature's method of cloning plants through seed," is a vegetative method of reproduction in which the embryo is formed without fertilization. Agamic complexes are usually arbitrary taxonomic groups of sexual and apomictic species that closely resemble each other morphologically. Since *P. orientale* is a polymorphic species, use of this species in forage improvement programs requires an extensive morphological and cytological analysis to identify and characterize the germplasm.

Richard (1805) originally described *P. orientale* from plants from the Orient. Later a general taxonomic description of *P. orientale* was given by Hrishikesh (1952). Sisodia (1972) compared the morphology of two *P. orientale* races and found the tetraploid race with longer leaves, longer tiller internode length, and longer panicle length compared to the diploid race. A triploid race of this species was described by Vishnuvardhan and Lakshmi (1983). These descriptions covered only a few characteristics of some races from different geographical regions. Morphological characteristics vary from one region to another depending on the environmental conditions. Hence, there was a need for better understanding of the nature of morphological differences among accessions. This study, wherein different *P. orientale* accessions were grown in a common location, will help to clarify relationships and to characterize the germplasm.

Avdulov (1931) first reported the somatic chromosome number of *P. orientale* as $2n=36$ although numbers of $2n=18, 27, 35, 36, 45$ and 54 have been reported as well (Chatterji & Timothy 1969; Dujardin & Hanna 1987). This suggests that $x=9$ is the base chromosome number and that aneuploidy frequently occurs. However, Sahni and Bir (1985) report a gametic chromosome number of $n=7$ for *P. orientale*. Confirmation of the chromosome numbers and the method of reproduction for the accessions of this species are reported by Ramu (1994). These are essential for moving the breeding programs forward.

MATERIALS AND METHODS

Eleven plant introductions (PI's) of *P. orientale* were selected for a study of morphological characteristics. These accessions, their country of origin, and collection number of the voucher specimens that are deposited in the S.M. Tracy Herbarium (TAES) are listed in Table 1.

Initial plantings of ten plants per accession were grown in the greenhouse during the fall of 1991. The plants were transplanted to the field west of College Station, Texas in early 1992. The soil at the field site is a Lufkin sandy loam with a pH of 8.3. The character list for the descriptive study is in Table 2. In addition, general growth habit of the plant was also recorded. For exact information on how each character was recorded refer to Ramu (1994). A pair-wise comparison among 11 accession means were tested for selected characters using the General Linear Model (SAS 1989) at alpha 0.05 level and the results tabulated in Table 3. Their ranges, means, and standard deviations for all the characters considered from the eleven accessions are listed in the Appendix of Ramu (1994). Chromosome counts were made from root tips using a modified Fuelgen technique (Hignight et al. 1991).

Table 1. *Pennisetum orientale* accessions included in the study.

Accession	Collection site	TAES*
PI 215600	India, between Kalka and Simla along road, Pepsu. 30,000' (1954).	201
PI 219610	India, Agriculture Research Station, Peshawar (1953).	202
PI 269961	Pakistan, pine forest, rocky hills, elevation 1200 m (1960).	203
PI 271593	unknown	204
PI 271596	India, steep wooded hills 20 km from Kalka, Simla Road to Nahan.	205
PI 314994	India.	206
PI 330717	Iran, Southern Esfahan.	207
433	India, seed obtained from ICRISAT.	208
PI 271595	India, steep wooded hills, high rainfall area, 28 miles from Kalka, Simla Kalka Road.	209
COWBOY	Released by G.E. Pogue Seed Co., Kenedy, TX.	210
PI 315867	Czechoslovakia.	211

* Collection numbers of the first author are deposited in the S.M.Tracy Herbarium (TAES).

RESULTS AND DISCUSSION

Species description of *Pennisetum orientale* L.C. Rich.

Morphological measurements were taken on the eleven accessions grown in a common garden at College Station, Texas.

Pennisetum orientale is a rhizomatous, perennial grass. *Rhizome scales* coriaceous. *Mid-rhizome scale* length 2.2–8.8 cm, mid-internode length 0.4–5.2 cm long. *Flowering culms* 38–149 cm tall, erect, much branched basally. *Ligules* 0.2–1.4 mm long, membranous. *Leaf blades* 12–35 cm long and 1.3–7.7 cm wide, linear to lanceolate, acuminate, glabrous to scabrous with ciliate margins. *Inflorescences* a panicle, 13.5–25.5 cm long and 2.6–5 cm wide, loose. First to second inflorescence internode lengths 0.5–10.5 mm long, second to third 0.5–7.7 mm long, and third to fourth 0.6–7.5 mm long. Involucre density 12–43 per basal 5 cm. *Bristles* in two series, length unequal, number inconsistent; inner bristles 6.5–18.5 mm long, ciliate with long hairs, green or purplish. Outer series of bristles 2.2–14 mm long, glabrous or scabrous, the two series are not always distinct. *Spikelets* per involucre ranged from one to five. Stipe scabrous to pubescent. Central spikelets 4.4–8.7 mm long, lanceolate; two florets per spikelet, occasionally three, lower floret triandrous or sterile, mostly staminate, upper floret perfect; *first glumes* 0.7–2.5 mm long, rudimentary, ovate to oblong, obtuse, veinless or faintly 1-veined; *second glumes* 0.8–4.8 mm long, ovate, lanceolate, veinless or 1- to 3-veined, usually 1-veined, acuminate; *lower floret lemmas* 3.4–6.2 mm long, ovate, lanceolate, 2-(7)-veined, usually 4-(5)-veined; *paleas* 2.3–5.7 mm long, oblong, obtuse, bifid, hyaline, 0- to 2-veined, usually 2-veined; *upper floret lemmas* 3.6–6.5 mm long, membranous, ovate, lanceolate, 5- to 7-veined, usually 5; *paleas* 3.5–5.9

TABLE 2. Character list used in the morphological analysis, including the units of measurement.

Vegetative:	
1.	Tallest tiller height (cm)
2.	Shortest tiller height (cm)
3.	Mid-rhizome internode length (cm)
4.	Mid-rhizome scale length (cm)
5.	Length of second uppermost leaf blade below the inflorescence (cm)
6.	Width of second uppermost leaf blade below the inflorescence (mm)
7.	Ligule length of second uppermost leaf blade below the inflorescence (mm)
Inflorescence:	
8.	Length of the inflorescence (cm)
9.	Width of the inflorescence (mm)
10.	Inflorescence internode length (from the base)-1st to 2nd (mm)
11.	Inflorescence internode length (from the base)-2nd to 3rd (mm)
12.	Inflorescence internode length (from the base)-3rd to 4th (mm)
13.	Number of involucre per lowest 5 cm section (#)
Spikelet:	
14.	Number of spikelets per involucre (mean of two involucre of the mid inflorescence) (#)
15.	Length of inner bristle of the above spikelets (mm)
16.	Length of outer bristle of the above spikelets (mm)
17.	Length of the central spikelet (mm)
18.	First glume length of the central spikelet (mm)
19.	Number of the veins of the first glume (#)
20.	Second glume length of the central spikelet (mm)
21.	Number of the veins of the central spikelet (#)
22.	Sexuality of the lowermost floret
23.	Lemma length of the lowermost floret (mm)
24.	Number of the veins of the lowermost floret (#)
25.	Palea length of the lowermost floret (mm)
26.	Number of the veins of the lowermost floret (#)
27.	Lemma length of the uppermost floret (mm)
28.	Number of the veins of the uppermost floret (#)
29.	Palea length of the uppermost floret (mm)
30.	Number of the veins of the uppermost floret (#)
31.	Filament length of the uppermost floret (mm)
32.	Anther length of the uppermost floret (mm)
33.	Stigma branch length of the uppermost floret (mm)
34.	Caryopsis length (mm)
35.	Caryopsis width (mm)

mm long, lanceolate, acuminate with involute margins, 2- to 4-veined, usually 2. *Stamens* 3; filament 4.3–10 mm long, anthers 1.1–3.2 mm long, yellowish or purplish, dehiscence by longitudinal pore; stigmas 2–6 mm long, two- branched, feathery; ovaries one-ovuled. *Caryopses* 1.2–2.6 mm long, 0.8–1.5 mm wide, elliptic. Flowering from spring until fall under favorable conditions. No disease or insect damage was observed at College Station, Texas.

The culm height and leaf measurements of this study were not consistent with those reported by Sisodia (1972) as 243.8 cm and 12.5 mm,

TABLE 3. Mean and Duncan groupings* of selected morphological characters of *Pennisetum orientale* accessions.

Accession tiller	Tallest tiller length (cm)	Shortest scale length (cm)	Rhizome internode length (cm)	Rhizome length (cm)	Leaf width (cm)	Leaf length (mm)	Inflorescence basal (cm)	Involucre/ 5 cm #	Spiklet/ involucre #	Caryopsis length (mm)	Caryopsis width (mm)	Ligule length (mm)	Central spikelet length (mm)	Upper filament length (mm)	Upper anther length (mm)
PI 215600	104.90 c*	50.88 f	4.30 abcd	2.99 abc	19.47cd	3.85 b	20.50 ab	23.50 d	1.85 f	1.93 bc	1.08 b	0.56 cd	6.40 a	6.73 c	2.00 d
PI 219610	115.39 b	57.96	3.73 d	2.50 bcd	24.02 ab	4.51 b	22.40 a	24.80 d	2.50 cde	2.07 abc	1.04 bc	0.57 c	5.75 bcd	7.76 b	2.16 cd def
PI 269961	136.32 a	81.66 a	4.99 abc	1.60 d	26.76 a	5.52 a	22.00 a	26.10 cd	3.75 a	2.12 b	1.09 b	0.73 b	5.30 ef	7.09 bc	2.17 cd
PI 271593	111.33 bc	60.71 de	4.05 bcd	2.51 bcd	21.77 bc	3.76 b	20.40 ab	30.80 ab	2.15 ef	1.68 d	0.94 d	0.51 cd	5.24 f	6.49 c	2.00 d
PI 271596	119.05 b	64.77 dc	4.82 abcd	2.49 bcd	24.63 ab	4.05 b	17.60 de	30.20 abc	2.95 bc	2.13 ab	1.08 b	0.58 c	5.62 cde	7.81 b	2.39 c
PI 314994	112.42 bc	65.41 dc	4.53 abcd	1.82 d	22.88 abc	4.10 b	17.70 de	30.00 abc	2.70 bcd	2.21 a	1.01 bcd	0.55 cd	5.56 def	7.87 b	2.36 c
PI 330717	109.80 bc	55.80 ef	3.83 cd	1.64 d	17.00 d	5.51 a	18.50 cd	23.50 d	3.10 b	1.94 bc	0.98 cd	0.50 cd	5.94 bc	8.81 a	2.71 b
433	119.33 b	70.69 bc	4.22 abcd	2.15 bcd	22.77 abc	4.33 b	21.60 a	32.30 ab	2.25 def	1.84 cd	1.01 bcd	0.45 d	5.55 def	7.95 ab	2.14 cd
PI 271595	132.21 a	73.53 b	5.15 ab	3.63 a	21.51 bc	4.13 b	21.10 ab	34.33 a	2.56 cde	2.20 a	1.02 bcd	0.49 cd	5.29 ef	7.73 b	2.16 cd
Cowboy	128.98 a	75.74 ab	5.39 a	3.09 ab	23.00 abc	4.15 b	19.60 bc	34.00 a	2.85 bc	2.07 abc	0.98 cd	0.52 cd	5.21 f	7.28 bc	2.23 cd
PI 315867	87.12 d	49.78 f	4.62 abcd	2.05 cd	23.30 abc	3.91 b	16.50 e	27.90 bcd	1.05 g	2.28 a	1.26 a	1.03 a	6.04 b	8.00 ab	3.00 a

* Duncan means followed by the same letter within a column are not significantly different at alpha = 0.05.

respectively. This could probably be due to ecological conditions at our common garden. However, involucre density is consistent with reports of Sisodia (1972) and Vishnuvardhan and Lakshmi (1983) and certain spikelet character observations of Hrishi (1952).

Chromosome counts from root tip cells showed that all the accessions examined were tetraploid ($2n=4x=36$). However, chromosome numbers ranging from $2n = 18, 27, 35, 45$ and 54 have also been reported in addition to $2n = 36$ (Chatterji & Timothy 1969; Dujardin & Hanna 1987).

Morphological analysis

A pair-wise comparison of tiller height of eleven accessions (Table 3) revealed that the tallest tiller heights were recorded in accessions 269961, 271595, and Cowboy. The tiller heights in accessions 219610, 271593, 271596, 314994, 330717, and 433 were intermediate, while 315867 had the shortest tillers.

Leaf blade length measurements show that PI 269961 blades were significantly longer than those of PI's 215600, 271593, 271596, and 330717. Leaf blade widths of PI's 269961 and 330717 were significantly wider than the other accessions. Taking leaf blade length and width together, PI 269961 had the largest leaves. PI 330717 had the shortest leaves and was significantly wider than all the other accessions except for PI 269961. Intermediate leaf blade sizes were recorded for all the other accessions. All accessions were rhizomatous, however, differences were also observed between accessions with respect to rhizome scale length and internode length. Cowboy had a rhizome scale length significantly longer than PI's 219610, 271593, and 330717. The smallest rhizome scale length was recorded in PI 219610. There appeared to be an association between rhizome scale length and internode length.

The long rhizome scale length observed in Cowboy and other accessions may protect the axillary buds of the rhizome from winter damage. In contrast, the shorter rhizome internode length and long scale length observed in 269961 indicates more meristematic buds per unit length. This may further enhance the plant's capacity for regrowth.

The suspected association of rhizome characters with winterhardiness might be addressed by multi-location trials where winter temperatures are more severe than College Station. No attempt was made in this research to quantify non-structural carbohydrate content, number of meristems per unit rhizome length or their association with winter survival.

The data for inflorescence length and width indicate that PI 219610 had the longest and widest inflorescences. Intermediate length and width were observed in Cowboy while the inflorescences of PI's 269961 and 433 were long with intermediate width. The smallest size inflorescence was observed in PI 315867.

Cowboy and PI 271595 had more involucre per basal 5 cm of inflorescence than PI's 215600, 219610, 269961, 330717, and 315867. With respect to spikelets per involucre, PI 269961 had the highest number of spikelets followed by PI's 330717, 271596, and Cowboy. However, seed set fertility data is needed to judge the agronomic usefulness of this morphological character.

Caryopsis (seed) size distribution across eleven accessions shows that PI 315867 had the largest seeds with the smallest seeds being observed in PI 271593.

With regard to growth habit, all the accessions were erect. PI's 269961, 433, 271595, and Cowboy had robust vegetative growth, whereas the remaining accessions were moderate, except PI 315867 which exhibited poor vegetative growth. The distinguishable character of PI 269961 is the drooping inflorescence giving the appearance of a bottlebrush.

Among the eleven accessions studied there were also some distinct taxonomic features such as the longest ligule length in PI 315867; and central spikelet length in PI's 215600 and 315867 which was significantly longer than all the other accessions. Furthermore, long anthers and filaments were observed in PI's 330717 and 315867.

The results of this study provide a better understanding of the nature of morphological differences among eleven *P. orientale* accessions. Based on plant heights, leaf blade lengths and widths, inflorescence density, and growth habit in a single area, the accessions 269961, 330717, 433, 271595, and Cowboy appeared to have the best forage potential. However, this needs to be supported by studies on nutritional quality.

This comprehensive basic descriptive study provides the range of diversity among the accessions introduced from five geographical regions of the world. However, there were limitations because the study was conducted in one location. Therefore applicability of the results obtained in locations other than College Station need to be tested. Efforts should be made to collect additional accessions of different ploidy levels and from other ecological regions to contribute additional diversity to the germplasm collection.

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ANNOUNCEMENT

The Gray Herbarium Card Index of New World Plants and the Harvard University Herbaria Type Specimen Collection Database

The Gray Herbarium Card Index and the Harvard University Herbaria Type Collection databases are now available on the World Wide Web through the Harvard University Herbaria Web page. The URL for the HUH Web site is: <http://www.herbaria.harvard.edu>

With the above URL, users will find a general outline of the Harvard University Herbaria, including "Databases," from which many searchable databases, including the Gray Herbarium Card Index, the Harvard University Herbaria Type Specimen Collections, the Farlow Diatom Collection, Botanical Collectors, and Botanical Authors can be accessed.

The Web page search form, for both the Gray Card Index and Type Collections, has multiple fields (such as Family, Genus, Specific & Infraspecific Epithets, Author, Publication, and Type). This allows users to make complex queries. Detailed instructions on searching are provided.

The Gray Herbarium Card Index provides bibliographic details for new taxa of vascular plants, new combinations, new status, and new names of New World Plants. It also includes information on infrageneric and infrafamilial names, and on types (including epi-, neo-, and lectotypification). From its inception (in 1893), the Gray Index included publication information for all specific and infraspecific names, basionyms, replaced synonyms, and other nomenclatural synonyms, but not taxonomic synonyms.

Although the original scheme of the Gray Index was designed to cover specific and infraspecific names published from 1 Jan 1886, it was later modified to include all infraspecific names published from 1753. An effort to include infraspecific names from this period is still underway. The information on infrageneric and infrafamilial names, and types starts from the early 1970s.

The Gray Index data, which was published in the form of printed cards until the mid 1980s and as microfiche until early 1992, has been made available over the Internet using Gopher since mid 1992. [Users may find additional information on the Web page "About the Gray Herbarium Index"]

The Type Collection database includes information on type specimens in the Harvard University Herbaria (A, AMES, ECON, FH, GH, NEBC), collected from all parts of the world. The data on Type Collections has also been available on Gopher since 1991. (Presently, Internet users may access the Gray Index data and Type Collections data through either gopher or the World-Wide web; however, at some point in the near future the Gopher services will be discontinued.)

An Appeal To The Users of The Gray Herbarium Card Index and Type Collections

The accuracy and completeness of the Gray Card Index and Type Collections databases depend largely upon the input of the users, who are urged to provide any relevant information (such as additions, omissions, and corrections to the data) via e-mail to either K. N. Gandhi (gandhi@oeb.harvard.edu) or David Boufford (boufford@oeb.harvard.edu).

NEW SPECIES OF UREDINALES ON BIGNONIACEAE FROM BRAZIL

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ABSTRACT

Five new species of rust fungi (Uredinales) from Brazil parasitizing plant host species in the family Bignoniaceae are described. The new species are: *Porotenus bibasiporulus*, *Porotenus biporus*, and *Uredo amapaensis* on *Memora* spp.; *Prospodium amapaensis* on undetermined Bignoniaceae, and *Prospodium laevigatum* on *Mansoa* sp.

RESUMO

Cinco novas espécies de fungos (Uredinales) são descritos, provenientes do Brasil, parasitando espécies de plantas hospedeiras da família Bignoniaceae. As novas espécies são: *Porotenus bibasiporulus*, *Porotenus biporus*, e *Uredo amapaensis* em *Memora* spp., *Prospodium amapaensis* em Bignoniaceae indeterminada e *Prospodium laevigatum* em *Mansoa* sp.

INTRODUCTION

The Uropyxidaceae, a family of nearly 200 species of plant rust fungi (Uredinales) worldwide, is composed of eleven genera, eight of which are neotropical. About 70 species distributed in four genera infect hosts mainly belonging to the Bignoniaceae. As part of our continuing research to monograph the Uropyxidaceae for the Neotropics, we propose five new species.

Porotenus is a small neotropical genus of five species, two on *Memora* spp. and one on *Amphilophium* sp., hosts belonging to Bignoniaceae. Two other species parasitize *Lippia* in the Verbenaceae (Cummins & Hiratsuka 1983). We add two new species on *Memora*. The four species of *Porotenus* on *Memora* are known only from Brazil.

Uredo is an anamorphic rust genus. Anamorphic taxa are also referred to as “imperfect” and “form” taxa. Anamorphic taxa are used to classify fungal spore states that represent only a part of the life cycle of a species. Connections to other spore states in the life cycle may or may not be known (Cummins & Hiratsuka 1983). Both *Uredo huallagensis* P. Hennings, known

only from the type from Tarapoto, Peru, and *Uredo amapaensis*, which we describe below, have morphology and hosts (*Memora* spp.) that suggest they will belong to *Porotenus* when other spore states are discovered.

Prospodium, with nearly 65 species, is the largest genus of Uropyxidaceae. It is strictly American, extending from northern Argentina to southern Texas and Florida in the Northern Hemisphere. Like *Porotenus*, it also parasitizes some members of Verbenaceae (*Lippia*, *Aloysia*, and *Lantana*) but most species occur on at least 19 genera of Bignoniaceae (Cummins 1940; Cummins & Hiratsuka 1983). We add two new species of *Prospodium* on Bignoniaceae.

The Bignoniaceae, with about 100 genera and 800 species worldwide, is primarily tropical and especially abundant in northern South America (Cronquist 1981; Gentry 1980, 1992). In Brazil about 41 species of Uredinales are known to parasitize plants of the Bignoniaceae (Hennen et al. 1982).

Although species concepts of rust fungi are based primarily on morphology, the various host specificity patterns of rusts are useful traits for their taxonomy. Knowledge of host identity, at least to family or genus, is often necessary for efficient identification of rust species (Cummins 1971; Gallegos & Cummins 1981; Lindquist 1982; Hiratsuka, N. et al. 1992). To identify rust species on the family Bignoniaceae it is useful to know that even though the teliospores of *Porotenus*, *Prospodium*, and some other genera of rusts that infect bignoniaceous plants may resemble closely the teliospores of the genus *Puccinia*, no species of *Puccinia* are known to produce teliospores on members of this family. This kind of host relationship is especially important for identifying species of *Puccinia*, the largest genus of rusts with nearly 4,000 species worldwide.

Hennen and Buriticá (1980) discussed some ideas about the evolutionary pathway mechanisms of rusts, where the fungus-plant relationship appears to be a great influence in the evolutionary process.

MATERIALS AND METHODS

The data are based on specimens in herbaria of the Biological Institute of São Paulo, Brazil (IBI), the Emilio Goeldi Museum of Pará at Belém, Brazil (MG) and the Botanical Research Institute of Texas at Fort Worth, Texas (BRIT).

Semipermanent microscopic slide preparations of spores and sori were made by scrape mounts and freehand thin sections from herbarium specimens. Spores or thin sections were mounted in standard lactophenol solution, heated and sealed. For better germ pore visibility some preparations were mounted in a saturated solution of chloral hydrate. Photomicrographic illustrations were made with differential interference contrast optics (Nomarski) and Polaroid type 55 positive/negative film.

POROTENUS TAXONOMY

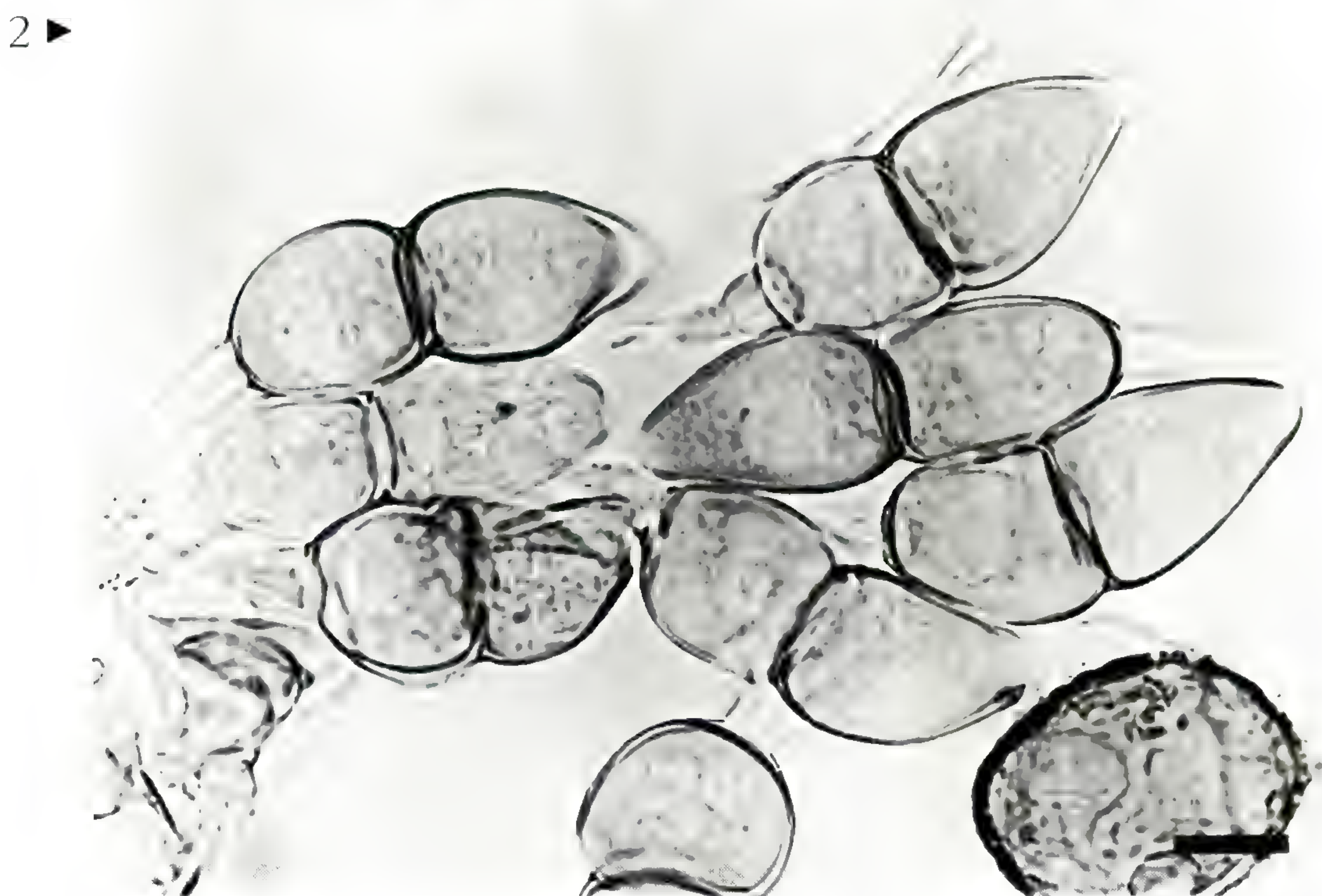
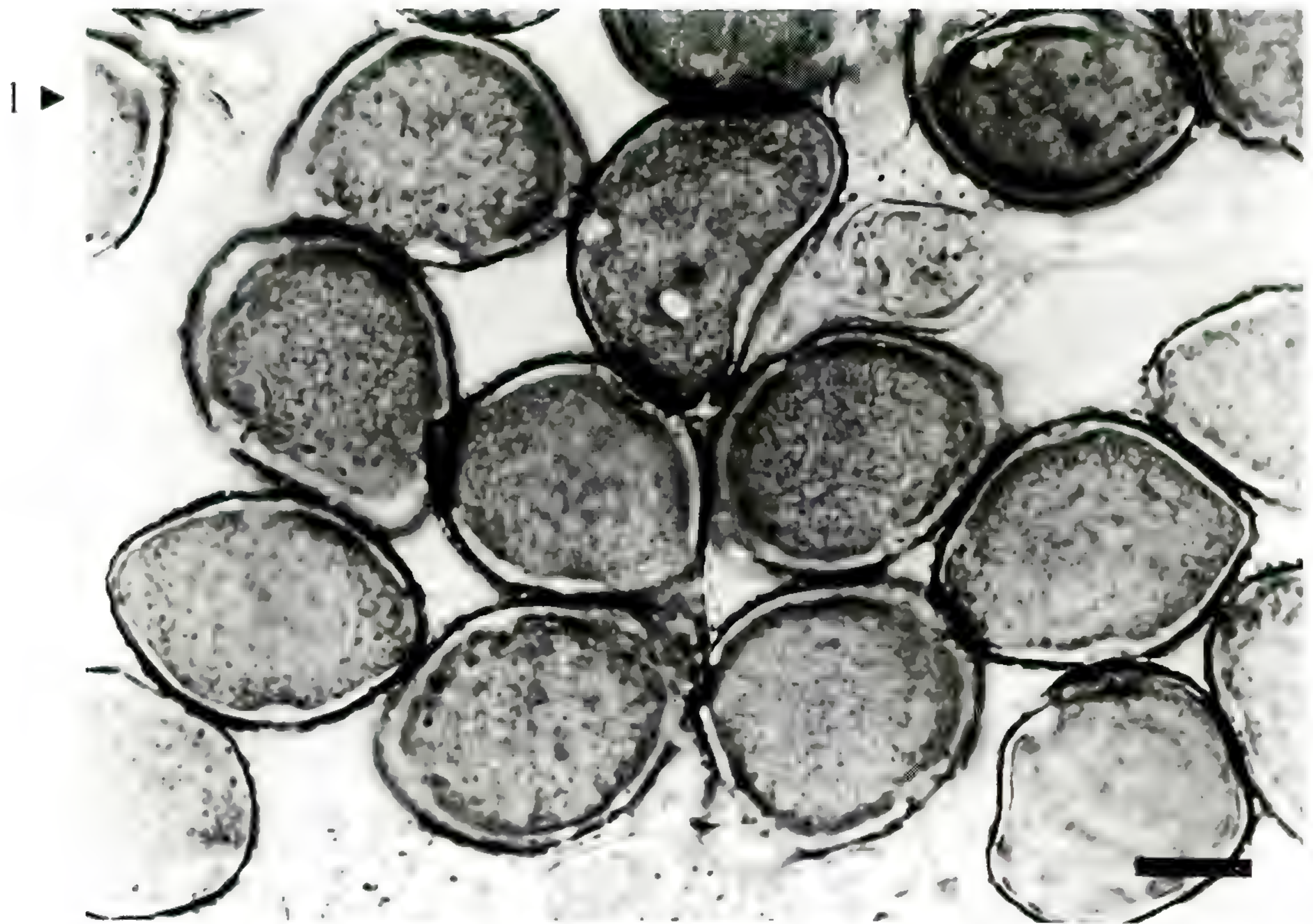
Telial traits in the four species of *Porotenus* on *Memora* are similar. Sori are scattered on the abaxial side of the leaflets, subepidermal in origin, erumpent, pulvinate, 0.1–0.5 mm across, and cinnamon-brown but become whitish as the spores germinate in situ. The spores are mostly two-celled, oblong-ellipsoid to cylindrical but often narrowed above, rounded below, somewhat constricted at the septa, and pedicellate; the walls are uniformly 1.0–1.5 μm thick, pale cinnamon-brown to nearly colorless, and smooth. Each probasidial cell has one germ pore at its distal end through which a metabasidium emerges on germination. Germination occurs without any noticeable dormancy period. Except for some overlapping spore size differences, telial traits are not useful for identifying species of *Porotenus* on *Memora*.

Variations in aecial and uredinial traits are more useful for characterizing these species. Sori are considered as aecial if they closely encircle small patches of spermogonia and develop from the same mycelium. In general, spermogonia and aecia are encountered much less frequently than uredinia. Uredinia are randomly scattered singly or in small irregular groups over the abaxial side of leaflets. They are not directly connected to spermogonia. Both aecia and uredinia are subepidermal in origin, become erumpent, with the broken epidermis usually remaining as a partial covering over the sorus. The sori are 0.1–0.5 mm across and somewhat powdery. The many loose spores produced in the sorus are chestnut-brown in mass. Each spore breaks off of its pedicel, leaving a definite scar termed a hilum at the proximal end of the spore. The spores are bilaterally symmetrical or radially asymmetrical usually with a convex and a concave side. The four species of *Porotenus* and one *Uredo*, including our new taxa on *Memora*, can be identified by their aeciospores or urediniospores using the following key.

1. Pores near the hilum 2
 2. Each spore with one pore on its convex, echinulate side, the concave side with a smooth patch **P. memorae** Albuquerque
 2. Each spore with two pores, both the convex and concave sides with a smooth patch **P. bibasiporulus** Hennen & Sotão
1. Pores on the sides of the spores, more or less equatorial 3
 3. Spore walls more or less evenly strongly echinulate, without smooth patches **U. amapaensis** Hennen & Sotão
 3. Spore walls with one or two smooth patches 4
 4. Wall with one smooth patch on the concave side, pores near the edge of the smooth patch **P. concavus** Viégas
 4. Wall with two smooth patches, one on the concave side, one on the convex side, pores in the echinulate area of the spore **P. biporus** Hennen & Sotão

***Porotenus biporus* Hennen & Sotão, sp. nov. (Figs. 1, 2)**

Spermogonia amphigena in gregis. Aecia spermogonia cingentia, sporis urediniosporis similibus. Uredinia hypophylla; sporis (33–)35–40(–42) $\times$ 24–30(–33) μm asymmetricis



FIGS. 1, 2. *Porotenus biporus*. Fig. 1. Urediniospores, median focus. Fig. 2. Teloisporae. Bar = ca 13 μ m.

late ellipsoidea vel ovoidea; poris 2, equatorialibus. Telia hypophylla; sporis (36–)40–49 $\times$ 17–22 μ m oblongo-ellipsoidea vel plus minusque cylindrica; episporio 1–1.5 μ m crasso, brunneolo vel praecipue hyalino laevi in cellula quaque poro apicali; pedicello tenuitunicato hyalino typice in fragmento curto; sporis non dormientibus.

Spermogonia amphigenous in groups on discolored areas that finally fall from the leaf leaving a little hole. Aecia arranged around the spermogonia, brown, spores pedicellate, similar to the urediniospores. Uredinia hypophyllous, scattered, dark brown, spores (33–)35–40(–42) $\times$ 24–30(–33) μ m, asymmetrical, broadly ellipsoid or oval with pores in optical section, slightly reniform with pores in the optical axis, wall 1.5–2 μ m thick, dark cinnamon-brown, with a longitudinal irregular band of echinulae in which there are two more or less equatorial pores. Telia hypophyllous, brownish, pulvinate, spores (36–)40–49 $\times$ 17–22 μ m, oblong-ellipsoid or more or less cylindrical, wall 1–1.5 μ m thick, pale brownish to essentially colorless, smooth, pore apical in each cell, pedicel thin-walled, colorless, usually broken short, spores germinate without dormancy.

TYPE: BRAZIL. PARÁ: near Belém, Mocambo Forest Preserve, on *Memora flavida* (A. DC.) Bureau & K. Schumann, 9 Jul 1979, J.F. & M.M. Hennen 79-153 (HOLOTYPE: IBI; ISOTYPE: BRIT).

Additional specimens examined: BRAZIL. Amapá: Maruanum, 27 Dec 1989, J. Hennen & H. Sotão 89-175 (BRIT, IBI); Serra do Navio, 7 Jan 1990, J. Hennen & H. Sotão 90-22 (BRIT, IBI). Distrito Federal: DF Hwy 15, 12 Feb 1981, E.P. Heringer et al 6195 (BRIT). Maranhão: São Luis, forest in Sacavem (CAEMA), 20 Jan 1990, J. Hennen & H. Sotão 90-61 (BRIT, IBI). Minas Gerais: 40 km E of Lavras on BR Hwy 116, 12 Mar 1984, J. & M. Hennen 84-250 (BRIT, IBI); 40 km E of Lavras, J. & M. Hennen 83-351 (BRIT, IBI). Pará: Belém, on *Memora flavida* (A. DC.) Bureau & Schumann, 5 Nov 1967, Albuquerque s.n. (PUR F17762); Belém, on the grounds of EMBRAPA, on *Memora* sp., 17 Jan 1990, J. Hennen & H. Sotão 90-43 (BRIT, IBI); Caxiuanã, Estação Científica Ferreira Penna, May 1994, J. & M. Hennen & H. Sotão 94-172 (BRIT, IBI).

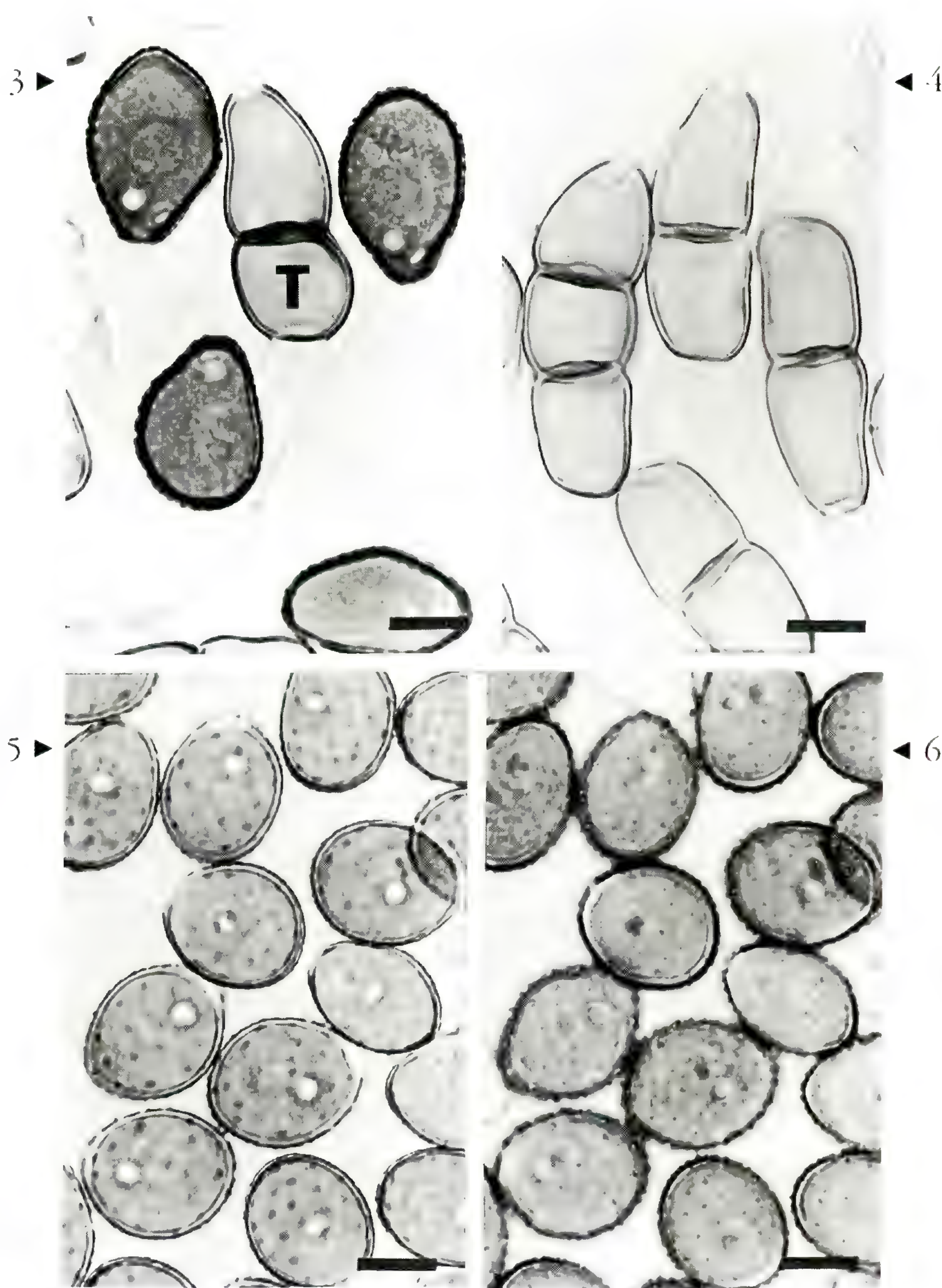
Etymology.—The specific epithet refers to the two pores in the urediniospores.

Distribution.—*Porotenus biporus* seems to be widespread in northeastern Brazil on several species of *Memora* from the cerrado and Amazon forest regions. Further field work is necessary, especially in the Amazon area to learn the full extent of its geographic and host range.

The concave and convex sides of the anamorph spores have large irregular smooth patches. The germ pores are along the sides opposite each other in the irregular echinulate band that surrounds the spore and separates the two smooth areas. Careful focusing on the spore surfaces is required for observing these traits.

***Porotenus bibasiporulus* Hennen & Sotão, sp. nov. (Figs. 3, 4)**

Spermogonia et aecia amphigena in areis parvis nigrescentibus hypertrophicatis, ad 5 mm diam.; aeciosporis et urediniosporis similibus. Uredinia hypophylla sparsa fuligenea; sporis



FIGS. 3, 4. *Porotenus bibasiporulus*. Fig. 3. Urediniospores and one teliospore. Fig. 4. Teliospores, note the unusual three-celled spore. Figs. 5, 6. *Uredo amapaensis*. Fig. 5. Spores, median focus. Fig. 6. Same as Fig. 5 but surface focus, note distribution of echinulae. Bar – ca 13 μ m.

(31–)34–43(–48) $\times$ (14–)18–24 (–25) μm , plerumque ellipsoideis 22–24 μm latis; telia hypophylla sparsa cinnamomea, coacti-pulveracea; sporis bilocularibus (parce trilocularibus), (40–)45–55(–66) $\times$ (15–)18–23 μm , plerumque fere cylindricis, leniter constrictis ad septum; episporio constanter 1–1.5 μm crasso laevi avellino vel fere hyalino; poro in cellula quaque apicali; pedicello hyalino tenuitunicato ad 50 μm longo.

Spermogonia and aecia amphigenous in small, blackened, hypertrophied areas to more or less 5 mm diam; aeciospores similar to urediniospores. Uredinia hypophyllous, scattered, dark brown, spores (31–)34–43(–48) $\times$ (14–)18–24(–25) μm , mostly ellipsoid and 22–24 μm wide with pores in the optical axis, strongly uniform and (14–)17–20 μm wide with pores lateral, thus conspicuously asymmetrical radially, wall uniformly 1.5 μm thick, chestnut-brown, echinulate except with two irregular smooth areas near the pores, pores 2, near the hilum. Telia hypophyllous, scattered, cinnamon-brown, felty-pulvinate, spores 2-celled (rarely 3-celled), (40–)45–55(–66) $\times$ (15–)18–23 μm , mostly nearly cylindrical except constricted at septa, wall uniformly 1–1.5 μm thick, smooth, pale golden to nearly colorless, pore apical in each cell, pedicel colorless, thin-walled, to 50 μm .

TYPE: BRAZIL. GOIÁS: dirt road off of Hwy 153 between Rialma and Rianópolis, on *Memora nodosa* (Manso) Miers, 15 Jul 1979, M.M. & J.F. Hennen 79-182 (HOLOTYPE: IBI; ISOTYPE: BRIT).

Additional specimens examined: BRAZIL. Dist. Federal: Brasília, on *Memora nodosa*, 20 May 1981, E.P. Heringer 2023 (BRIT). Goiás: Luziânia, on *Memora* sp., 20 May 1982, E.P. Heringer 2219 (BRIT); 18 km SSW of Jataí, km 364, 18 Jul 1988, J.F. Hennen & M.M. Hennen & R.M. Lopez 88-58 (BRIT, IBI). Minas Gerais: Três Marias, 25 Jun 1972, Inneco 4 (MO 2630750, BRIT-leaf fragment); 13 km SE of Paracatu, 19 Nov 1983, J.F. & M.M. Hennen 83-758 (BRIT, IBI).

Etymology.—The specific epithet refers to the two pores in the lower part of the urediniospores.

Uredo buallagensis P. Hennings (Hedwigia 43:161. 1904) on *Memora* sp., from Tarapoto, Peru, Ule s.n., 1902 (in Ule's exsiccata, *Mycotheca brasiliensis*, n.23), also has two basal pores but perhaps is not synonymous, the pigmentation being much paler and the radial asymmetry much less pronounced.

Uredo amapaensis Hennen & Sotão, sp. nov. (Figs. 5, 6)

Spermogoniis, aecidia et teliis ignotis. Soris anamorphis hypophyllis, sparsis, 0.01 mm diam., cinnamomeus-brunneus, erumpentibus; sporis 26–31(–33) $\times$ 17–23(–24) μm , asymmetric, late ellipsoideis, ovatis vel badius, echinulatis, 2 poris germinationis plus minusve equatorialibus.

Spermogonia, aecia and telia unknown. Sori hypophyllous, scattered, 0.1 mm across, cinnamon-brown, pulverulent, ruptured epidermis evident; spores 26–31(–33) $\times$ 17–23(–24) μm , asymmetrical, broadly ellipsoid or oval with pores in optical section, slightly reniform with pores in optical

axis, wall 1–1.5 μm thick, pale chestnut-brown, more or less evenly strongly echinulate, pores 2, more or less equatorial.

TYPE: BRAZIL. AMAPÁ: Camaipí, on *Memora* cf. *magnifica* (Martius ex A. DC.) Bureau, 15 Nov 1987, J.F. Hennen & H. Sotão 87-124 (HOLOTYPE: IBI; ISOTYPES: BRIT, MG).

Additional specimens examined: BRAZIL. Pará: Caxiuanã, Estação Científica Ferreira Penna, on *Memora* cf. *magnifica* (Martius ex A. DC.) Bureau, 2 May 1994, J.F. & M.M. Hennen & H. Sotão 94-173 (BRIT, IBI, MG); Caxiuanã, IBAMA, 3 May 1994, J.F. & M.M. Hennen & H. Sotão 94-182 (BRIT, IBI, MG); 20 Nov 1995, H. Sotão et al 95-308 (BRIT, IBI, MG).

Etymology.—The specific epithet refers to the Brazilian state of Amapá.

This species is closely allied to the three species of *Porotenus* on *Memora*. The more or less evenly and strongly echinulate urediniospores differ from other species, all of which have irregular smooth areas. The three specimens from Caxiuanã (J.F. Hennen & H. Sotão 94-173, 94-182, 95-308) have larger spores than those from the type, 33–48(–51) $\times$ (15–)18–35(–38) μm .

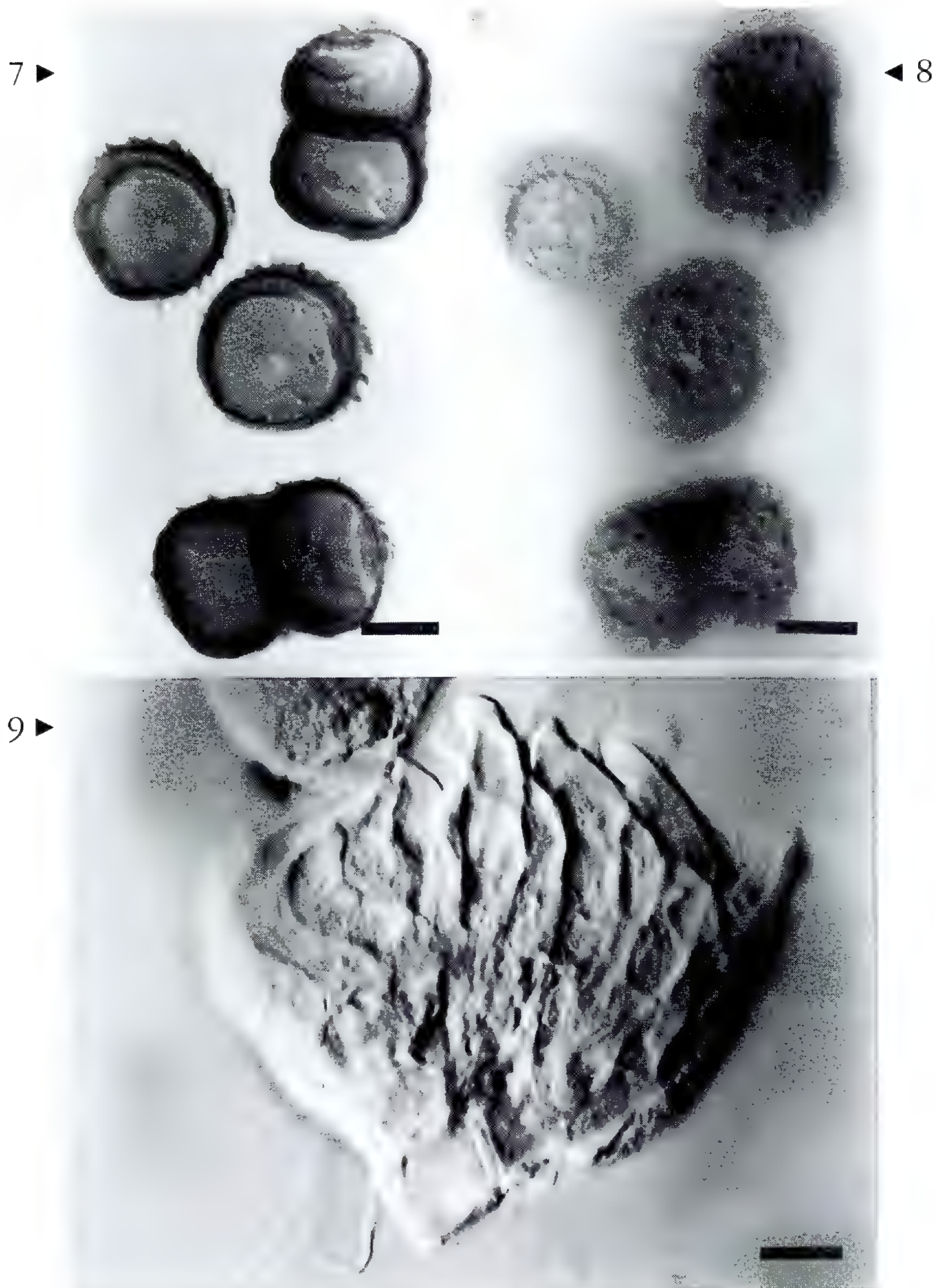
PROSPODIUM TAXONOMY

Three informal groups of species were recognized by Cummins (1940) based on soral traits and kind of life cycle: 1) aecia, uredinia, and telia subepidermal in origin and erumpent, *Euprospodium*; 2) aecia subepidermal—erumpent, but uredinia and telia suprastomatal, *Cyathopsora*, 3) microcyclic, only spermogonia and telia, *Nephlyctis*. Our two new species belong to *Cyathopsora*, a group of about 15 species characterized by a sorus that develops as a minute basket-like structure from hyphae that emerge through stomata (suprastomatal).

Prospodium amapaensis Hennen & Sotão, sp. nov. (Figs. 7–9)

Spermogonia et aecia ignota. Uredinia hypophylla sparsa, suprastomatales, 0.2–0.5 mm diam., cyathiformes, cum paraphysibus 31–40 $\times$ 6–9 μm ; sporis late globoideis vel globosis, poris 2, aequatorialis, poris a latarella visis, episporio bilaminato, bicapitato, strato exteriori aculeato. Telia instar uredinearum; sporis 33–47 $\times$ 24–29 μm , ad septum leniter constrictes ad septum apicem, episporio constanter 2–3 μm crasso.

Spermogonia and aecia unknown. Uredinia scattered on adaxial side of leaflets, suprastomatal, 0.2–0.5 mm across, brown, pulverulent; sori composed of a circular basal peridium surmounted with paraphyses around the margin, paraphyses 31–40 $\times$ 6–9 μm ; spores 21–30 $\times$ 19–29 μm ; globoid to broadly ellipsoid, wall 1–1.5 μm thick, yellowish-brown incompletely two layered, the outer layer forming a longitudinal ring of irregularly interconnected spines, the ring divides distally to form a low crown (Cummins & Hiratsuka 1983, use the term “bicapitate” for this trait). The area of the lateral walls between the ring has widely spaced spines and two equatorial and opposite germ pores. Telia like the uredinia but light chestnut brown; spores 37–47 $\times$ 24–29 μm , broadly ellipsoid, broadly rounded above and



FIGS. 7–9. *Prospodium amapaensis*. Fig. 7. Two urediniospores, center, and two teliospores, median focus, note “halo” of echinulations around urediniospores. Fig. 8. Same as Fig. 7 but surface focus, note that some echinulae are joined to each other. Fig. 9. Suprastomatal basket-like soral peridium, lateral view. Bar = ca 13 μ m.

below, with a small umbo above and slightly constricted at the septum; wall evenly 2–3 μm thick, echinulate with echinulae irregularly and widely spaced with echinulae sometimes basally interconnected; pore apical in upper cell and near the pedicel in the lower cell; pedicel usually without appendages and broken near spore.

TYPE: BRAZIL. AMAPÁ: ca 10 km from Mazagão (ca 40 km SW of Macapá), on undetn. Bignoniaceae, 14 Nov 1987, *J.F. Hennen & H. Sotão* 87-120 (HOLOTYPE: IBI; ISOTYPES: BRIT, MG).

Etymology.—The specific epithet refers to the Brazilian state of Amapá.

Prospodium amapaensis belongs to a group of six other *Prospodium* species which are characterized by suprastomatal sori that are “basket like” (section “*Cyathopsora*,” Cummins 1949), and the urediniospores have an apical corona (“bicapitate,” Cummins 1949). Within this group, *P. amapaensis* is most similar to *P. tabebuicola* on *Tabebuia* from Puerto Rico but *P. tabebuicola* has teliospores that are larger, not so obtuse above and below, and are obviously constricted at the septum. Their walls are bilaminar, the outer layer thin, translucent, and noticeable especially at the septum.

Prospodium laevigatum Hennen & Sotão, sp. nov. (Figs. 10–12)

Spermogonia plerumque epiphyllis. Aecia hypophyllis, confluent, pulverulentus, cinnamomeus-brunneus; sporis 21–24 $\times$ 20–23 μm . Uredinia ignotis. Telia hypophyllis, sparsa, suprastomatales; peridium flavidus, 40–55 μm crasso; sporis 28–35 $\times$ 17–21 μm , oblongus ellipsoideus et valde constrictus ad septum, episporio 1.5 μm crasso, aureus vel pellucidus cinnamomeus-brunneus, levis.

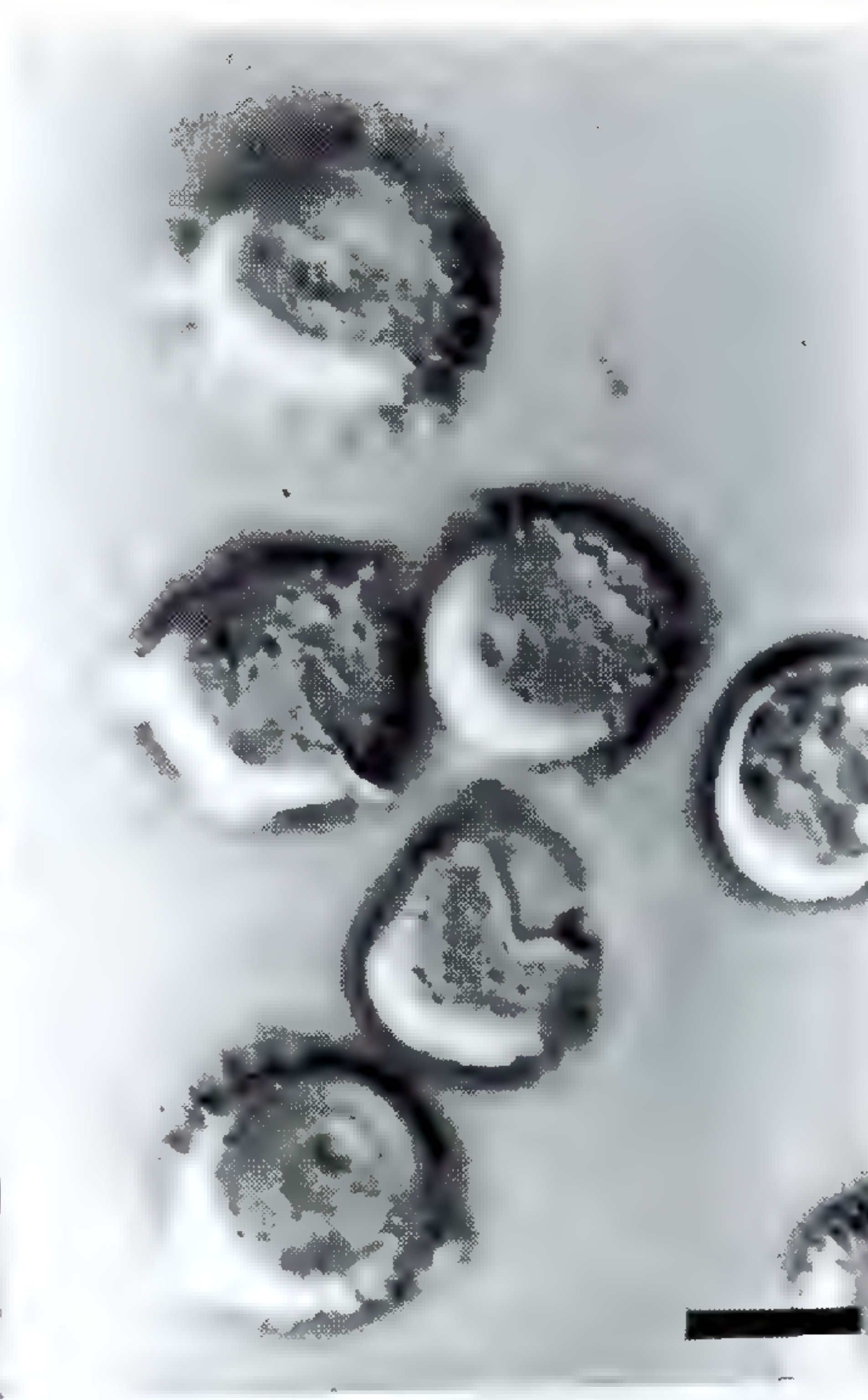
Spermogonia mostly epiphyllous, few in a group. Aecia hypophyllous opposite the spermogonia, confluent in a more or less circular group, pulverulent, cinnamon-brown; spores mostly 21–24 $\times$ 20–23 μm , globoid or essentially so, the inner wall clear chestnut-brown, the outer layer apically coronate, absent over the pores, beset with bacilliform papillae, forming a complete halo when pores are in face view, but showing only as two caps or “ears” laterally from the apex; pores 2, equatorial in the smooth sides. Uredinia not seen, probably not produced. Telia hypophyllous, scattered suprastomatal, cyathiform with a basal, yellowish peridial cup 40–55 μm diam., the rim of the cup with low knobs (scarcely paraphyses); spores mostly 28–35 $\times$ 17–21 μm , oblong-ellipsoid and strongly constricted at septum, the cells nearly globoid, wall uniformly 1.5 μm thick, golden or clear cinnamon-brown, smooth, with a low lenticular, hyaline umbo over each pore, pore apical in upper cell, at septum in lower cell; pedicel thin-walled, colorless, fragile, about 25 μm long, without appendages; germination occurs without dormancy.

TYPE: BRAZIL. PARÁ: Belém, Mocambo Forest Preserve, on *Mansoa kerere* (Aublet) A. Gentry, 9 Jul 1979, *J.F. & M.M. Hennen* 79-153A (HOLOTYPE: IBI; ISOTYPE: BRIT).

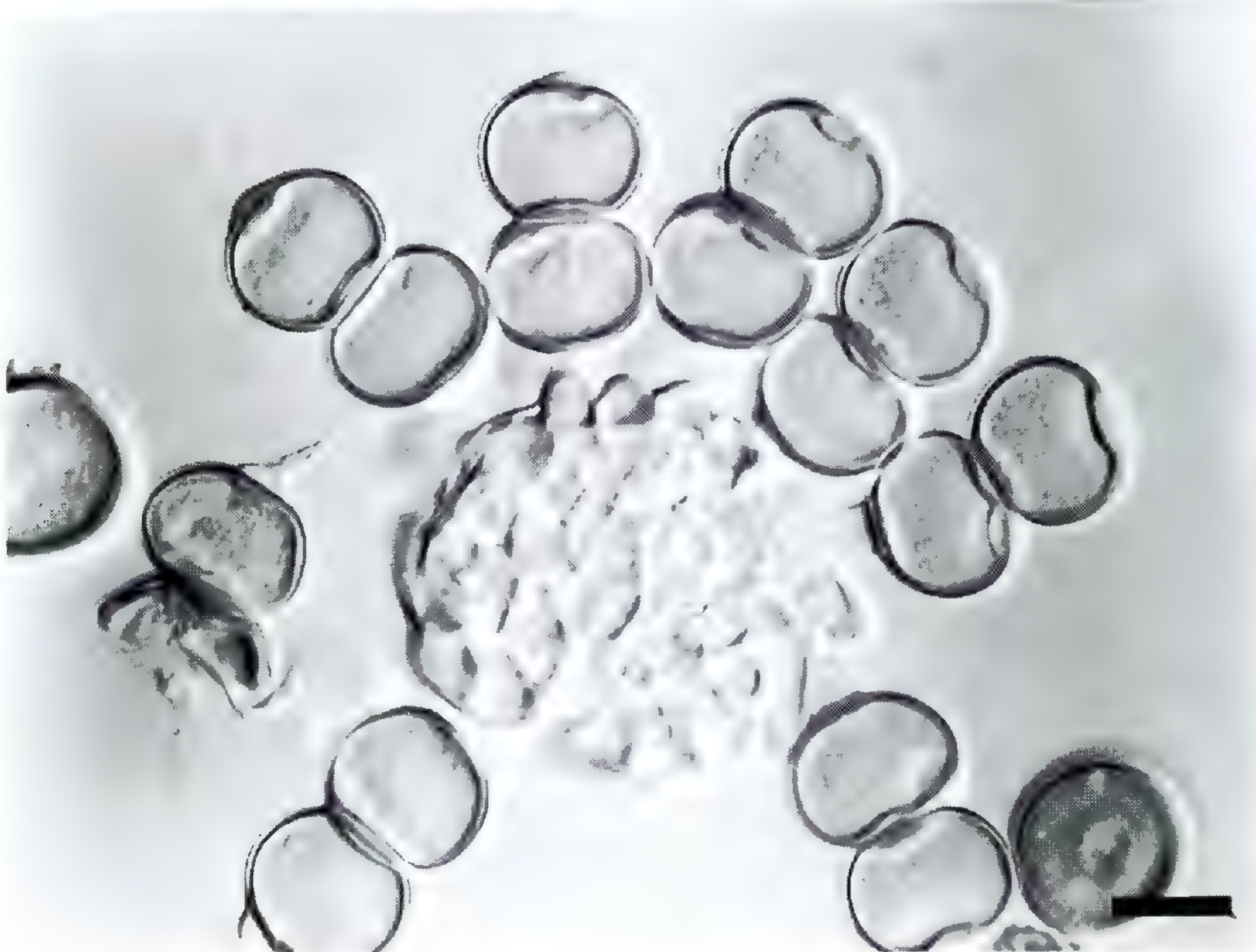
10 ►



◄ 11



12 ►



FIGS. 10–12. *Prospodium laevigatum*. Fig. 10. Aeciospores, median focus, note (arrows) the apical corona that has a bicapitate or “two eared” appearance. Fig. 11. Same as Fig. 10 but surface focus. Fig. 12. Suprastomatal telial sorus. View of bottom of sorus with teliospores emerging from top. Bar = ca 13 μ m.

Etymology.—The specific epithet refers to the smooth walled teliospores.

Prospodium laevigatum is the only species of the *Cyathopsora* group with smooth teliospores and coronate aeciospores. Only four other species of *Prospodium* have teliospores with smooth walls. Uredinia are probably lacking from the life cycle.

ACKNOWLEDGMENTS

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A NEW COMBINATION IN *THEVETIA* (APOCYNACEAE)

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ABSTRACT

Recent studies of Mexican Apocynaceae have led to a reevaluation of the taxonomic status of *Thevetia peruviana* (Pers.) K. Schum. var. *pinifolia* Standl. & Steyererm. The taxon is here viewed as specifically distinct and elevated accordingly with the new combination, *Thevetia pinifolia* (Standl. & Steyererm.) J.K. Williams, comb. nov.

RESUMEN

Los estudios recientes sobre las Apocynaceae mexicanas han permitido una reevaluación del estatus taxonómico de *Thevetia peruviana* (Pers.) K. Schum. var. *pinifolia* Standl. & Steyererm. Este taxon se ve aquí como una especie distinta y por consiguiente es elevado de rango con la nueva combinación, *Thevetia pinifolia* (Standl. & Steyererm.) J.K. Williams, comb. nov.

Key Words. *Thevetia*, Apocynaceae, Flora, Mexico

In their original description of *Thevetia peruviana* var. *pinifolia*, Standley & Steyermark remarked that they were inclined to recognize the new taxon as a distinct species (Leavenworth 1946). They refrained from this course, however, because they interpreted two herbarium specimens as having leaves that were intermediate in form between the putative taxa. A reexamination of these plants, (*MacDaniels* 244 and *Palmer* 27; F), indicates that they do not share with the typical variety a set of newly discovered characters. Instead, these plants are merely narrow leaved forms (4 mm wide) of *T. peruviana* (6–20 mm wide). Furthermore, these “intermediates” are growing without the range of the typical variety, and it is suspected that they are not native but rather cultivated individuals. This hypothesis is founded on two principles; (1) given the cultivated popularity of *Thevetia peruviana*, it is difficult to ascertain its natural habitat (Woodson 1938), and (2) the “intermediates” were collected from the vicinity of Acapulco, an area of artificial development.

The only character that Standley & Steyermark used to distinguish var. *pinifolia* from var. *peruviana* was leaf dimension: filiform vs. linear-lanceolate, respectively. Field observations, along with a significant accumulation of herbarium specimens, has revealed alternative characters that separate var.

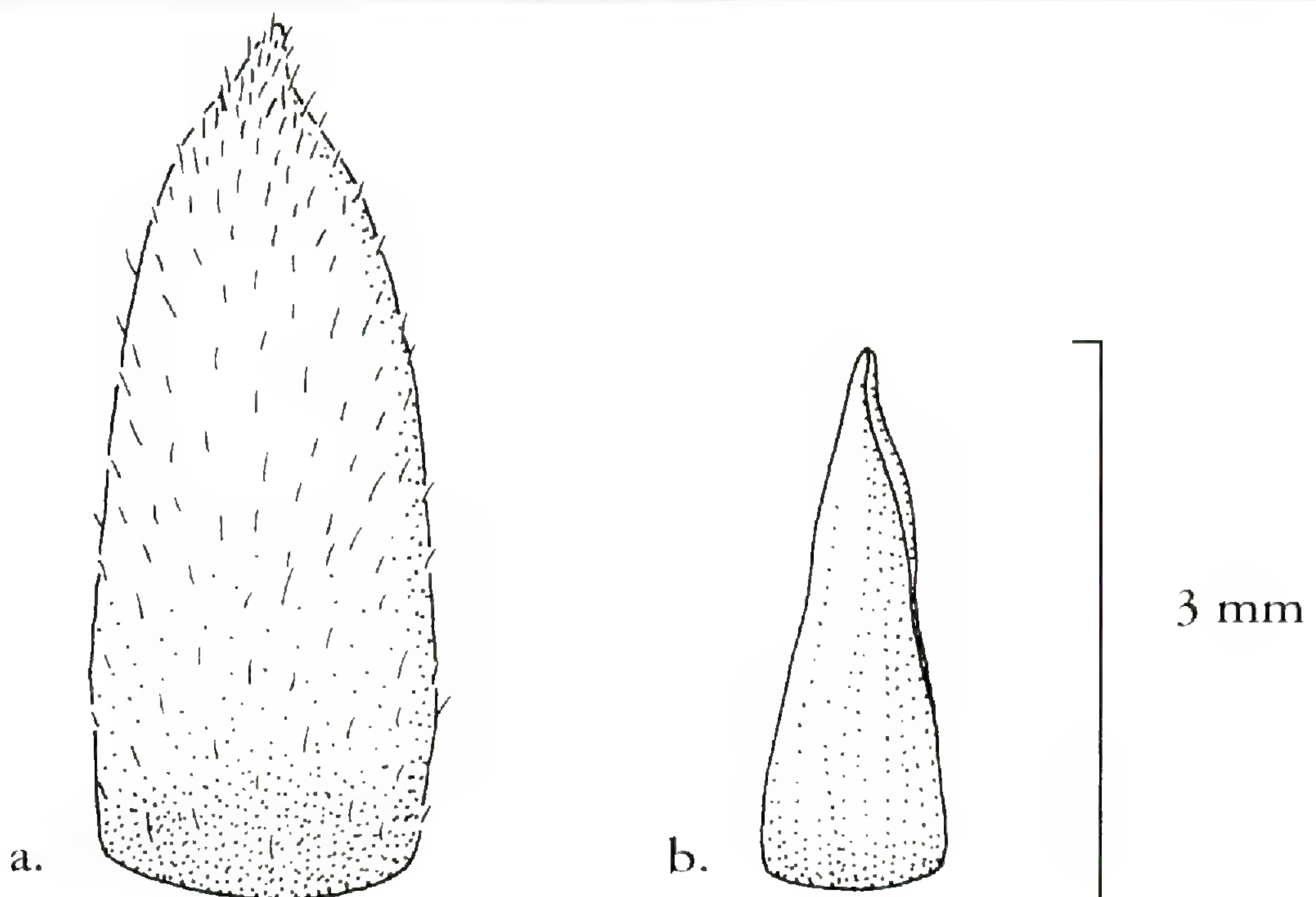


FIG. 1. Bracts of *Thevetia pinifolia* (a) and *T. peruviana* (b).

pinifolia from var. *peruviana*. The new traits are pubescence (vs. wholly glabrous), spreading corolla lobes (vs. erect), ovate bracts (vs. lanceolate) (Fig. 1), and an isolated geographical range (Fig. 2) (vs. widespread throughout Mexico and Central and South America).

The var. *peruviana* does share several features with var. *pinifolia*. There is essentially no difference in the shape and dimensions of their calyx, corolla, and fruit. Also, both taxa lack prominent secondary lateral veins on the surface of their leaves, an important diagnostic feature emphasized by Woodson (1938). The only other species of *Thevetia* lacking lateral veins, *T. gaumeri* Hemsl., is wholly glabrous, has elliptic leaves, and ovate bracts.

Although var. *pinifolia* does not have secondary lateral veins on its leaves, it possesses other characters similar to a species that does: *T. ovata* (Cav.) A. DC. Both var. *pinifolia* and *T. ovata* have pubescence along their stems, leaves, and inflorescence. They also have similar geographical ranges, spreading corolla lobes, ovate bracts, and both possess similar calyx and corolla dimensions. Another species of *Thevetia* with secondary lateral veins and pubescence, *T. thevetioides* (H.B.K.) K. Schum., has flowers twice the size of var. *pinifolia*, *T. peruviana*, and *T. ovata*.

Given that var. *pinifolia* has a combination of characters used elsewhere in the genus to discern species, it seems evident that the taxon is a distinctive element showing little if any character intergradation with *Thevetia peruviana*. Because of this var. *pinifolia* is elevated to the rank of species.

The two species can be readily distinguished by the following key:

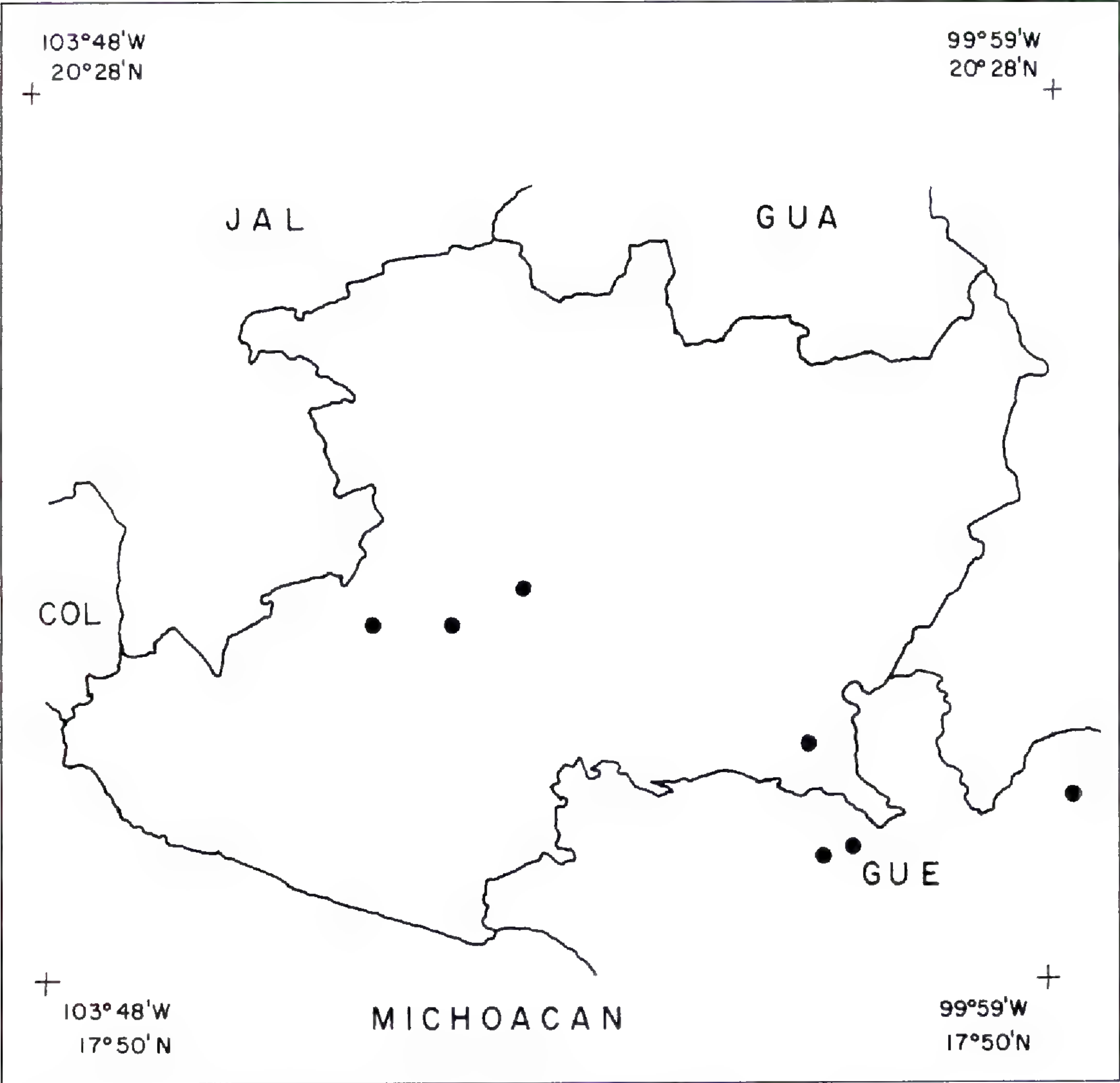


FIG. 2. Documented distribution of *Thevetia pinifolia*.

- 1. Leaves filiform, 1–2 mm wide, (9–)10–17 cm long; plants with peduncles, branches of new shoots, petioles, underside of leaf, bracts, and calyx pubescent; corolla lobes spreading, tube glabrous inside; bracts ovate, 4–5 mm long, 2 mm wide (Fig. 1); fruits with shallow median ridge; restricted to Michoacan and Guerrero (Fig. 2) ***T. pinifolia***
- 1. Leaves lanceolate, (4–)6–15(–20) mm wide, 8–12(–15) cm long; plants wholly glabrous; corolla lobes erect, tube with indument inside; bracts lanceolate, 2–3.5 mm long, 1 mm wide (Fig. 1); fruits with large median ridge; widespread throughout Mexico and extending into Central and South America, commonly cultivated in both hemispheres (Fig. 3) ***T. peruviana***

Thevetia pinifolia (Standl. & Steyerl.) J.K. Williams, comb. nov. BASIONYM: *Thevetia peruviana* (Pers.) K. Schum. var. *pinifolia* Standl. & Steyerl., Amer. Midl. Naturalist 36:185. 1946. TYPE: MEXICO. MICHOACAN: trail from Apatzingan to Tancitaro, 2,500 ft, 7 Aug 1940, W.C. Leavenworth 505 (HOLOTYPE: F!; ISOTYPES: GH, NY).

Shrub to 4.5 m; new branches sparsely pubescent, 2–5 mm wide. Leaves at the upper 5–20 cm of new branch growth, sessile, filiform, entire, dark

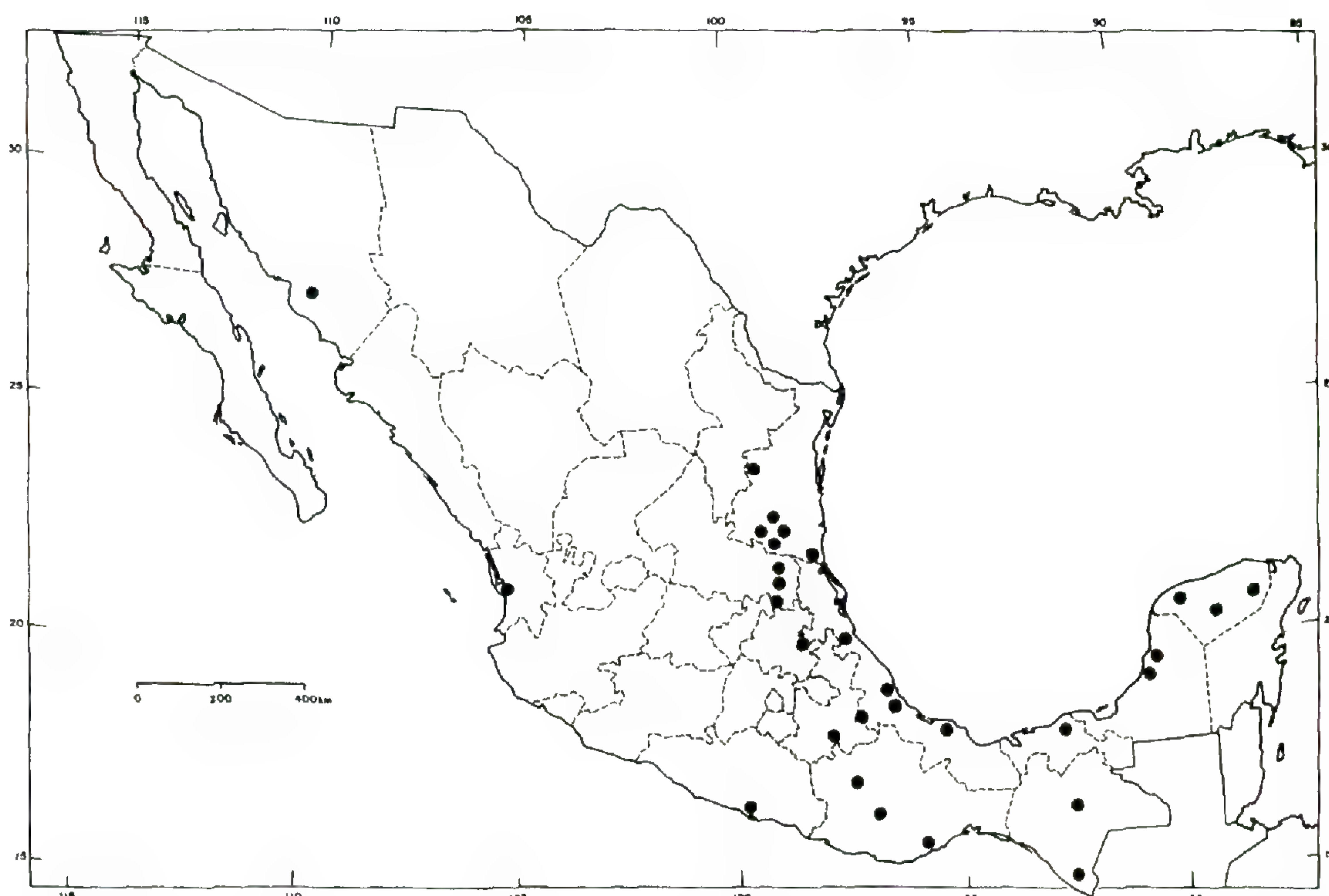


FIG. 3. Documented distribution of *Thevetia peruviana* in Mexico, documentation by Gensel (1969).

green, (9–)10–17 cm long, 1–2 mm wide; blade 0.5 mm wide on either side of midrib, lateral veins absent, pubescent along the bottom 4 mm. Inflorescence terminal, of 2–5(–7) flowers; peduncles 1.5–3.0 cm long, pubescent; bracts ovate, 4–5 mm long, 2 mm wide, pubescent; pedicels 1.0–2.5 cm long, pubescent. Calyx of five sepals, connate at the extreme base; sepals ovate, 7–10 mm long, pubescent, 6–10 colleters per sepal. Corolla infundibuliform, yellow, 40–50 mm long; tube 10–15 mm long, pubescent within along the upper portion of tube where grading into the cup, glabrous along the bottom four-fifths of tube; cup 9–15 mm long, glabrous within; lobes 20–30 mm long, spreading, glabrous. Anthers five, free, along the top edge of the tube protruding into the cup, past the infrastaminal hairs. Fruits a four-seeded drupe, 3–4 cm tall, 3–5 cm wide, greenish when ripening, blackish when mature.

Representative specimens. **MEXICO.** Guerrero: Mpio. Zirandaro, 29 km SW of Zirandaro, road to Guayameo, 13 Jun 1982, *Salas 1336* (MO); Mexicaltepec, 8 km al NW of Inguala, 14 Oct 1981, *Nunéz 3339* (MEXU); Mpio. de Coyuca de Catalan, in Placeres del Oro, 20 Mar 1980, *Nunéz 2038* (MEXU); en Paso de Arena, 18 km al SW de Coyuca de Catalan, 17 May 1978, *Nunéz 660* (MEXU); Placeres del Oro, 2 Aug 1937, *Hinton et al. 10532* (TEX; MO; US); Placeres del Oro, 28 Jul 1936, *Hinton et al. 9178* (TEX; MO; US); Coyuca, 3 Apr 1935, *Hinton et al. 7579* (MO; US). Michoacan: Road to Tancitaro, 2 km N of Apatzingan, growing in ravine along creek, 23 Aug 1995, *J.K. Williams 95-56* (TEX); carretera entre Gallina y Gabriel Zamora, 5 km antes de Gallina, Aug 1987, *Luna 18263*

(TEX); en Las Colonias, Huetamo, *Martinez* 3639 (MEXU); En Huetamo, en El Barrio Alto, 26 Mar 1982, *Nunéz* 3890 (MEXU); 2 km al SE de Pinzandaro, 9 Aug 1978, *Rzedowski* 35724 (MEXU); 13 km W of Apatzingan, 4 May 1966, *Rzedowski* 22307 (TEX; US); Apatzingan, arid slope with scattered trees, 13 Aug 1941, *Leavenworth* 1477 (F); bank of Río Apatzingan, 5 Aug 1940, *Leavenworth* 463 (F); Apatzingan, 15 Aug 1938, *Hinton et al.* 12018 (F; TEX; US); Huetamo, 1 Mar 1934, *Hinton et al.* 5716 (US).

Distribution.—This plant is apparently endemic to the tropical scrub forests of Michoacan and Guerrero, growing chiefly along arid plains and canyons between 360–1,000 m. It is interesting to note that this species shares a similar habitat and range with another apocynaceous endemic in Apatzingan (the type locality for both taxa), *Echites woodsoniana* Monachino (Williams, pers. obs.), a taxon that was recently collected by the author (*Williams* 95-80; TEX) not more than 30 m from a stand of *T. pinifolia*. Another rare apocynaceous taxon, *Fernaldia asperoglottis* Woodson, has also been collected from Apatzingan (*Hinton et al.* 15329; TEX), and surrounding Guerrero (the type locality).

After submitting the manuscript for review, it was brought to my attention (Nesom, pers. comm.) that Gensel (1969), in an unpublished masters thesis, had independently recognized *T. pinifolia*. All but one of the characters we used to differentiate *T. pinifolia* from *T. peruviana* were different. I did not notice the presence of indument in the corolla tube of *T. peruviana*, nor did I recognize a difference in the median ridge of the fruit. Gensel did not recognize the difference in external pubescence nor the shape of the bracts. From field work, however, we independently noticed the spreading corolla lobes of *T. pinifolia* and the erect lobes of *T. peruviana*. I have included the characters discussed by Gensel (1969) in the key. I should point out the Gensel annotated the two “intermediates” (see above) as *T. pinifolia*. The flowers of these specimens have been destroyed through the years and it is not possible to examine the inside of the corolla tube for indument. However, the specimens have lanceolate bracts and lack external pubescence, for these reasons I treat them as *T. peruviana*.

In several villages near Apatzingan the plants appear cultivated, but upon questioning the natives I was informed that the plants were wild and that they had removed the surrounding vegetation for farming, leaving *Thevetia* for aesthetic purposes.

Label data on *Nunéz* 2038 notes that children eat the pulp of *Thevetia* fruits. Although Morton (1982) reports that all parts of the plant except the pulp contain toxic glycosides (ex. thevetin and peruvoside) consumption of the pulp by children is not recommended as the seeds are highly toxic (Woodson 1937). A child's accidental swallowing of only one to two seeds will typically result in their death. The average toxic dosage for an adult is eight to ten seeds.

ACKNOWLEDGMENTS

I am grateful to Guy Nesom for informing me of the Gensel thesis, and to the curators of the following herbaria for allowing me the opportunity to observe their specimens: F, BRIT, LL, MEXU, MO, TEX, US.

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UNA NUEVA ESPECIE DE AGAVE SUBGENERO AGAVE (AGAVACEAE) DE MEXICO

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RESUMEN

Se describe *Agave montana* como especie nueva de la región de la Sierra Madre Oriental. Está relacionada con *A. gentryi* y *A. parrasana*, pero difiere de ambas por sus rosetas grandes con hojas más numerosas, panículas ovadas con mayor número de ramas floríferas y brácteas dentadas. Se presenta una ilustración con los detalles de la planta.

ABSTRACT

Agave montana is described as a new species from the Sierra Madre Oriental. It is related to *A. gentryi* and *A. parrasana* but differs from both in its larger rosettes with more numerous leaves, ovate panicles with higher number of floriferous branches and armed bracts. A detailed illustration is included.

Colectas realizadas en la cima de la sierra de la Marta en los límites de los estados de Coahuila y Nuevo León, adicionan una nueva especie de *Agave* subgénero *Agave*.

***Agave montana* Villarreal, sp. nov. (Figs. 1 y 2)**

Agave gentryi Ullrich affinis, sed rosula compacta 1.4–1.6 m in diametro, foliis numerosioribus ellipticis viridi-flavis, inflorescentia ovata, ramis floriferis numerosioribus, bracteis denticulatis et floribus 6–7 cm longis discrepans.

Plantas multianuales, no rizomatosas; rosetas hemisféricas, compactas, 1.40–1.65 m diámetro, 90–1.25 m alto; hojas arregladas en 12–16 hileras, 84–112 por planta, cortamente elípticas, ligeramente cóncavas a casi planas, 30–40 cm largo, 15–17 cm ancho, de color verde-amarillento, base ensanchada, apice acuminado con borde de color café-púrpura, espina de 3–5 cm largo, margen recto, con 16–18 dientes grisáceos antrorsos y retrorsos por lado, separados 2.5–3.5 cm; inflorescencia 3.5–4.5 m alto, ovoide, con alrededor de 30 ramillas florales, de 25–35 cm largo, ubicadas en las 2/5 partes superiores del escapo; brácteas elípticas, 18–25 cm largo, 8–12 cm ancho, con dientes marginales y espina terminal, cóncavas, succulentas, café-rojizas, cubriendo completamente el tallo floral; tallo floral 12–16 cm diámetro; flores 6–7 cm largo, amarillas, succulentas; pedicelos 1–1.5 cm largo; ovario 3 cm largo; tubo del perianto 2 cm largo, 12–14 mm ancho;

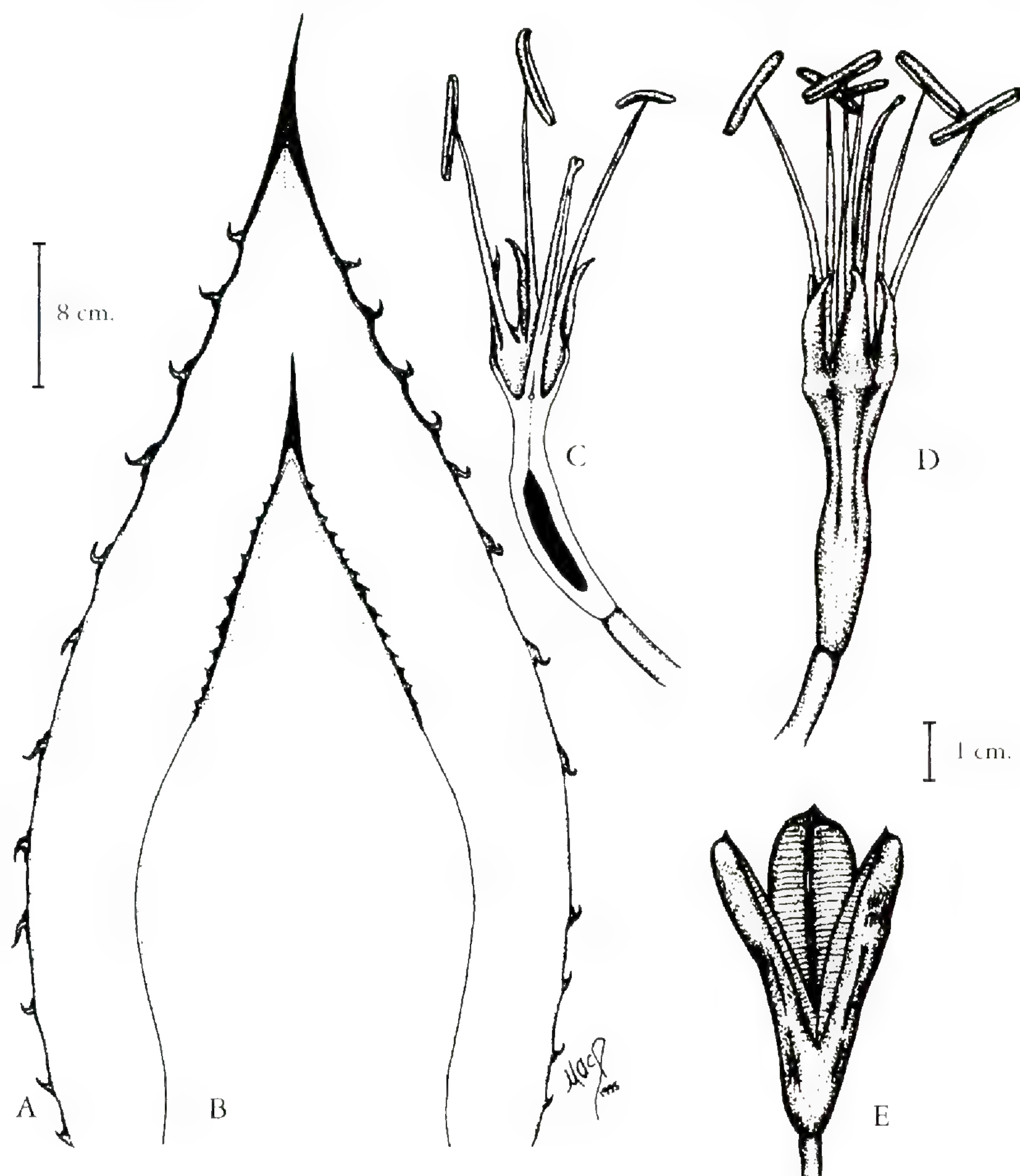


FIG. 1. *Agave montana* A. Hoja. B. bráctea. C. flor, corte longitudinal. D. flor y E. cápsula.

tépalos lanceolados, 2 cm largo, 3–4 mm ancho; filamentos 5–6 cm largo, 3 mm ancho, aplanados, insertos en la base de los tépalos; anteras de 19–20 mm largo, 2 mm ancho, amarillas; cápsulas oblongas, 5–6 cm largo, 1.5–2 cm ancho, de color café oscuro; semillas lacrimiformes, 5–6 mm largo, 3–4 mm ancho, de color negro brillante.

TIPO: MÉXICO. NUEVO LEÓN: Municipio de Rayones, cima de la sierra de la Marta, 42 km al E de San Antonio de las Alazanas, 25°09'N, 100°23'W, matorral bajo de *Arctostaphylos pungens*, *Ceanothus buxifolius*, *Pinus culminicola*, *P. bartwegii*, *Quercus greggii*, *Ceanothus greggii*, *Cercoarpus*, entre otras, 3,300 m, 5 May 1995, J.A. Villarreal 8120, M.A. Carranza y J.A. Encina (HOLOTIPO: MEXU; ISOTIPOS: ANSM, ENCB).

TABLA 1. Comparación de algunas características entre *Agave montana*, *A. gentryi* y *A. parrasana*.

Caracter	<i>Agave montana</i>	<i>Agave gentryi</i>	<i>Agave parrasana</i>
Diámetro de la planta	140–165 cm	60–100 cm	30–50 cm
Hijuelos rizomáticos	ausentes	presentes	ocasionales
Número de hojas	85–115	30–45	40–60
Limbo de la hoja	casi plano	cóncavo	casi plano
Tamaño de hoja	30–40 × 15–18 cm	60–100 × 17–26 cm	20–30 × 10–15 cm
Tipo de dientes	curvos	casi rectos	curvos
Color de hoja	verde-amarillento	verde	glauco-grisáceo
Forma de la panícula	ovada	elíptica	elíptica
Número de ramillas florales	20–30	10–18	10–15
Borde de brácteas	dentado	entero	entero
Longitud de flores	6–7 cm	7–9 cm	5–6 cm

Material adicional examinado: Localidad tipo, 6 Sep 1994, J.A. Villarreal 7905 y M.A. Carranza (ANSM).

La especie descrita se localiza en la sierra de la Marta, en laderas de rocas calizas con exposición W-SW entre los 3,200–3,400 m. La población es esparcida extendiéndose por toda la ladera en una comunidad más xerofila que la de la exposición contraria de la misma sierra.

Agave montana está relacionada con *A. gentryi* Ullrich (nombre asignado por Ullrich (1990) al tradicionalmente conocido *A. macroculmis*) y con *A. parrasana* Berger por su tallo floral gueso y completamente cubierto por brácteas cóncavas y succulentas, así como por su habitat en bosques de pino-encino de la Sierra Madre Oriental. Una comparación de las características más sobresalientes de estos taxa se presenta en la Tabla 1.

La nueva especie se diferencia por sus rosetas de aproximadamente 1.5 m de diámetro, con hojas de color verde amarillento y en mayor cantidad, así como en el borde dentado de las brácteas. Se distingue de *A. gentryi*, la especie al parecer más cercana, por las hojas más cortas y numerosas, casi planas y de color verde amarillento, panículas ovadas, más anchas cerca de la base, con mayor número de ramillas florales y flores más pequeñas (Tabla 1).

La descripción para *A. macroculmis* en Gentry (1982) y la de *A. gentryi* por Ullrich (1990) son muy amplias e incluyen características de las dos especies (*A. gentryi* y *A. montana*). La nueva especie propuesta puede separarse siguiendo las características de la Tabla 1, por lo que *A. gentryi* se restringe a plantas con rosetas laxas de 60–100 cm de diámetro, hojas largamente elípticas 60–100 × 17–26 cm, cóncavas, de color verde oscuro,



FIG. 2. *Agave montana* en su habitat y plantas en floración y fructificación.

inflorescencias en panículas elípticas, más anchas en la parte media, con 10–28 ramas floríferas, bráctetas enteras y flores de 7–9 cm largo.

Las tres especies comparadas en el Tabla 1 comparten una serie de caracteres y se les puede agrupar bajo las siguientes características:

Plantas pequeñas a tamaño medio; rosetas compactas con hojas numerosas o laxas y menor número de hojas; hojas menos de 1 m largo; pedunculo largo y grueso con brácteas elípticas, cóncavas, succulentas, erectas, con tintes rojo-purpura, cubriendo totalmente o casi totalmente el tallo floral, con amontonamiento de brácteas debajo de la panícula; panículas ovadas de 1/3–2/5 del escapo floral; floración en primavera; distribución en la Sierra Madre Oriental.

AGRADECIMIENTOS

Se agradece la revisión del manuscrito y la diagnosis en Latín al Dr. J. Rzedowski y la elaboración del dibujo al biólogo Miguel A. Carranza P.

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BOOK REVIEW

NELSON, CHARLES E. and ALLAN PROBERT. 1994. **A Man Who Can Speak of Plants.** (ISBN 0 9524847 06, pbk). privately published by Dr. E. Charles Nelson, 14 Connaught Parade, Phibsborough, Dublin 7, Ireland, \$30.00, 181 pp, 8 color plates, 52 b/w.

This book is the life story of Dr. Thomas Coulter (1793–1843), an Irish botanist that lived and worked in Mexico and California in the 1820s and 1830s. He was a physician and also a naturalist with broad interests in animals and plants. He discovered and his name is forever enshrined as part of the binomial for the big-cone pine (*Pinus coulteri*) and the white-blossomed poppy, matilija (*Romneya coulteri*). His plant collections, especially of Mexican cacti, were distributed to botanical gardens in Europe.

His talents extended far beyond the study of botany, including insects and reptiles, and activities such as angling, shooting, managing silver and lead mines, and as a surveyor. The book is organized chronologically, tracing his life from youth in a beginning chapter Child and university student (1793–1820); his middle years Student of Botany (1820–1824) - 15 pages; Miner and physician in Mexico (1824–1829) - 60 pages; Explorer and plant-hunter in California (1829–1834) - 21 pages; to his final failing health and death 'A wreck of a man' his final decade (1834–1843). His failing health and early death limited his publication productivity once his collecting days were over.

The botanical content of this book is rather limited when compared to Coulter's other life activities. One of the highlights of Coulter's botanical career was his study and monograph of the Dipsacaceae (teasel and scabious family) under the tutelage of the famous botanist Augustin-Pyramus de Candolle of Geneva, Switzerland. Coulter's trip to lower California has commentary about the excessive heat, his poor health and the lack of interesting plants. Here he meets David Douglas who is a Scottish botanist collecting plants for William Hooker of the Royal Horticultural Society of London. The title of this book comes from a letter written by Douglas that praises Coulter for his botanical work and refers to him as "a man who can speak of plants." Many of Coulter's collections come from the environs of Monterey where he found the big cone pine, *Pinus coulteri*, and four other new species of pines. The beautiful white flowered Matilija poppy was named to honor Coulter by his friend Dr. Romney Robinson, *Romneya coulteri*. This beautiful species is surely Coulter's finest memorial and was introduced into cultivation in Europe about 1875. William Harvey described new genera from Coulter's California's collections: *Lyrocarpa coulteri* and *Dithyrea californica* (Brassicaceae, the cabbage family); *Whitlavia grandiflora* and *W. minor* in the Hydrophyllaceae; and *Berginia virgata*. Many of Coulter's collections are at Trinity College, Dublin where he established this famous herbarium with his own New World collections. He is also noted for his famous pine cone collection. He never published any papers on his Mexican and California collections and named no new species from America.

Appendix I provides a glossary of Spanish words and mining terms. Appendix II provides the original texts of Coulter's letters about upper California to the Royal Geographical Society of London. Appendix III has Thomas Coulter's herbarium specimens, but this is not a complete listing of all the new taxa based on Coulter's collections. Such a list may not have been possible to compile but it certainly would provide valuable reference information.

Anyone interested in the floras of Mexico and California will welcome this book as an important source of botanical history on plant exploration in the early 1800s.—*Harold W. Keller, Research Associate, BRIT.*

THE MEXICAN GENERA OF THE APOCYNACEAE (SENSU A. DC.), WITH KEY AND ADDITIONAL TAXONOMIC NOTES

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ABSTRACT

A key to the apocynaceous genera of Mexico is presented. The study is based on literature, field observations, and herbarium studies. The family is represented in Mexico by thirty genera (twenty-five native, four Old World cultivars, and one South American cultivar) and approximately ninety species (eighty-five native, four Old World cultivars, and one South American cultivar). Bibliographical references for the native genera are included, as are illustrations, a distribution list of genera by state, and a table of morphological novelties.

RESUMEN

Se presenta una clave de los géneros de Apocynaceae de México. El estudio está basado en bibliografía, observaciones de campo y estudios de herbario. La familia está representada en México por treinta géneros (veinticinco autóctonos, cuatro del Viejo Mundo y uno de Sudamérica). Se incluyen referencias bibliográficas para los géneros autóctonos, así como ilustraciones, una lista de distribución de géneros por estados y una tabla con las novedades morfológicas.

KEY WORDS: Apocynaceae, Asclepiadaceae, Flora, Mexico

In the course of revisionary studies on various apocynaceous genera it came to my attention that the identification of numerous specimens as to genus, in several major herbaria, was erroneous. The following key has been constructed to serve as a supplementary aid to the identification of the apocynaceous genera of Mexico. Considerable detail and repetition has been included in the key to insure the utmost accuracy. I have avoided the use of minute (ex. calycine colleters) and variable characters (ex. phyllotaxy) whenever possible, however, as there is considerable convergence within the family, at times their use was necessary. The characters used within the key do not necessarily represent the entire genus, but merely represent it for those species growing within Mexico. It should also be emphasized that the key is in no way meant to reflect natural groupings; after various efforts it was deemed more effective to arrange it artificially.

The native Apocynaceae genera in Mexico are in an alphabetical list following the generic key. Recognition of genera and their accepted names

within the list and key has been adopted from Leeuwenberg (1994). Generic synonyms within the list have been included only for those names that I have seen used in the current literature and various herbaria. The number of species in Mexico (approximate or exact) for each genus is given in the list. The species epithet is given within the key for all genera represented in Mexico by one species. The most recent and pertinent revisionary studies (dating from 1930), as well as publications of newly described species (the state of the type locality is provided), have also been provided for all of the New World genera. I have not included references for any of the Old World, non-native, cultivated genera: *Carissa*, *Catharanthus*, *Nerium*, and *Vinca*. All cultivated genera are represented in Mexico by one species (given in key). A list of general works on the Apocynaceae of Mexico and related areas (References), a tentative list of the distribution of all native genera in Mexico by state (Table 1), and a list of morphological novelties (Table 2) have also been provided. Illustrations have been included for only those characters that most readily represent the particular taxon in question and that distinguish it from morphologically similar genera.

TABLE 1. A list of the distributions, by state, of the native genera of the Mexican Apocynaceae.

SPECIES	BJN	BJS	SON	CHI	COA	NUE	TAM	SIN	DUR	ZAC	AGU	SAN	NAY	JAL
Alstonia														X
Amsonia			X	X	X				X					
Apocynum				X	X	X	X							
Aspidosperma														
Cameraria														
Echites														X
Fernaldia							X					X		
Forsteronia														X
Haplophyton			X	X	X									
Laubertia								X						X
Mandevilla			X	X	X	X	X	X	X			X		X
Mesechites														
Odantadenia														
Pentalinon												X		
Plumeria		X	X	X						X		X	X	X
Prestonia							X							X
Rauvolfia								X				X	X	X
Rhabdadenia														
Stemmadenia			X	X				X				X	X	X
Tabernaemontana							X	X				X	X	X
Telosiphonia		X	X	X	X	X	X	X	X	X		X	X	X
Thevetia			X				X	X				X	X	X
Thenardia														X
Tintinnabularia														
Vallesia		X	X	X			X							X

Lastly, it should be noted that with the recent advent of cladistic analysis it has become evident that the Apocynaceae as traditionally circumscribed is paraphyletic. Judd et al. (1994) have recently suggested the inclusion of the Asclepiadaceae within the Apocynaceae. Although this view is becoming more widely accepted (Struwe et al. 1994) I treat the Apocynaceae (sensu A. DC., de Candolle 1844) here in its traditional sense (i.e., distinct from the Asclepiadaceae).

The following key is based on literature, field observations, and herbarium studies from the following institutions: BRIT, F, LL, MEXU, MO, TEX, and US.

KEY TO THE GENERA OF MEXICAN APOCYNACEAE

1. Anthers free from pistil head, bases obtuse (prolonged into a fork in *Allamanda*, *Tabernaemontana*, and *Stemmadenia*); aestivation of corolla bud to the left (right in *Haplophyton cimidium* A. DC.); plant an herb, shrub, or tree, rarely scandent (*Allamanda*); leaves alternate, opposite, or whorled; fruit a dry or fleshy follicle, berry or drupe; seeds entire, winged, or ciliate along margin (*Alstonia*), not comose or if so then both apically and basally comose (*Haplophyton*) 2

COL	GUA	QUE	HID	MIC	MEX	MOR	TLA	PUE	VER	GUE	OAX	TAB	CPS	CAM	YUC	QUI
					X			X	X	X	X		X			
									X	X	X		X	X	X	X
									X			X		X	X	X
				X					X	X			X	X	X	X
		X		X	X			X	X	X	X		X		X	X
X									X	X	X	X	X			
				X		X		X			X		X			
				X	X	X				X	X					
	X	X	X	X	X	X		X	X	X	X	X	X		X	X
									X				X			
													X			
									X		X		X	X		X
								X	X	X	X		X		X	X
X				X					X	X	X		X			X
X				X	X			X	X	X	X		X	X	X	X
									X			X	X	X	X	X
X				X	X	X	X	X	X	X	X	X	X	X	X	X
			X	X	X			X			X					
X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X
				X	X	X				X	X		X			
													X			
		X						X	X		X		X			X

TABLE 2. External morphological novelties of Apocynaceae genera and species found in Mexico.

Plants spiny:	<i>Carissa macrocarpa</i> (Ecklon) A. DC.
Plants densely yellow tomentose:	<i>Prestonia grandiflora</i> L. O. Wms., <i>P. mexicana</i> Donn. Smith
Leaves alternate:	<i>Amsonia</i> , <i>Aspidosperma</i> , <i>Haplophyton</i> , <i>Plumeria</i> , <i>Thevetia</i> , <i>Vallesia</i>
Leaves whorled:	<i>Allamanda</i> , <i>Alstonia</i> , <i>Nerium</i> , <i>Rauvolfia</i>
Leaf hairs with multi-cellular bases:	<i>Haplophyton</i>
Leaves subcordate:	various species of <i>Mandevilla</i>
Leaves with colleters on the adaxial apex of petiole:	<i>Forsteronia</i> , <i>Mandevilla</i> , <i>Mesechites</i> , <i>Telosiphonia</i> , <i>Tintinnabularia</i>
Leaves with glands along the adaxial midrib:	<i>Mandevilla hirsuta</i> (Rich.) K. Schum., <i>M. subsagittata</i> (R. & P.) Woodson, <i>M. villosa</i> (Meirs) Woodson
Leaves with domatia in the axils of the abaxial midrib:	<i>Forsteronia</i> , <i>Tintinnabularia</i>
Corolla tube twisted:	<i>Echites umbellata</i> Jacq., <i>Laubertia</i>
Corolla with thickened annulus around mouth:	<i>Laubertia</i> , <i>Prestonia</i>
Calyx of four sepals, the outer two fused, inner two free:	<i>Aspidosperma megalocarpon</i> Müll. Arg.
Calyx colored:	<i>Prestonia portobellensis</i> (Beurl.) Woodson (purple), <i>Tintinnabularia</i> (burgundy)
Filaments coiled:	<i>Thenardia floribunda</i> Kunth
Anthers with distinct filamentous apical appendages:	<i>Cameraria</i> , <i>Nerium</i> , <i>Pentalinon</i> , <i>Tintinnabularia</i>
Anther exserted:	<i>Forsteronia</i> , <i>Laubertia</i> , <i>Prestonia</i> , <i>Tabernaemontana amygdalifolia</i> Jacq. (only slightly so in <i>T. alba</i> Mill.), <i>Thenardia</i>
Fruits of two fused follicles:	various species of <i>Mandevilla</i> , <i>Thenardia</i>
Fruits spiny:	<i>Allamanda</i>
Fruits red:	<i>Carissa</i> , <i>Rauvolfia</i> , <i>Thevetia abouai</i> (L.) A. DC.
Seeds winged:	<i>Allamanda</i> , <i>Aspidosperma</i> , <i>Plumeria</i>
Seeds with both basal and apical coma:	<i>Haplophyton</i>
Seeds with ciliate margins:	<i>Alstonia</i>

- 2 (1). Plants with spines in the axils of the leaves; fruit an indehiscent brownish-red berry, seeds embedded in a pulp; occasionally naturalized species **Carissa macrocarpa** (Ecklon) A. DC.
2. Plants without spines; fruit a follicle, berry or drupe; native or cultivar 3
- 3 (2). Anthers with distinct apical filamentous appendages; inflorescence of 1–5(–8) flowers, flowers white; fruits resembling single seeded samaras **Cameraria latifolia** L.
3. Anthers without distinct apical filamentous appendages; inflorescence of 1–80 flowers, flowers blue, pink, red, yellow, or white; fruits not samaras 4
- 4 (3). Flowers with two distinct nectaries adjacent to ovary; plant herbaceous; occasionally naturalized species 5
- 5 (4). Plant prostrate; flowers solitary in leaf axils, funnelform, blue; corolla tube not apically constricted; filaments bent and longer than anthers; anthers incompletely fertile; nectaries shorter than ovary **Vinca minor** L.
5. Plant erect; flowers 2–4 in axillary cymes, salverform, red, white, or pink; corolla tube apically constricted; filaments straight and shorter than anthers; anthers completely fertile; nectaries as long as or longer than ovary **Catharanthus roseus** (L.) G. Don
4. Flowers with a solitary annular nectary or nectary absent; plant a herb, tree or shrub; native or cultivated 6

- 6 (4). Suffrutescent herb; flowers yellow; inflorescence reduced to a solitary flower in leaf axil; petals of the bud overlapping to the right (*H. cimidum* A. DC.) or overlapping to the left (*H. crooksii* (L. D. Benson) L.D. Benson); leaves alternate to subverticillate; leaf hairs with multi-cellular bases; fruit a linear follicle; seeds with both basal and apical coma **Haplophyton** 7
- 6. Herb, tree, or shrub; flowers bluish, white, or yellow; inflorescence of many flowers; petals of the bud overlapping to the left; leaves alternate, opposite, or whorled; leaves glabrous or if pubescent then with simple hairs; fruit a linear or circular follicle, berry, or drupe; seeds without coma, or if pubescent then with a ciliate margin (*Alstonia*) 7
- 7 (6). Leaves alternate 8
- 8 (7). Herbaceous perennial to 0.7 m high; flowers bluish; fruit a linear follicle with many simple seeds; restricted to northern Mexico **Amsonia**
- 8. Tree or shrub from 1–35 m tall; flowers white, yellow, or red; fruit a linear or circular follicle with many winged seeds, or drupe with one-four nutlets; distributed throughout Mexico 9
- 9 (8). Tree from 7–35 m; calyx of 4 sepals, outer 2 fused and inner two free (*A. megalocarpon* Müll. Arg.), or five regular sepals (*A. spruceanum* Benth.); fruit a circular follicle, with many winged seeds **Aspidosperma**
- 9. Shrubs from 1–6 m tall; calyx of 5 free sepals; fruit a broad follicle, berry or drupe 10
- 10 (9). Flowers to 1.5 cm long, typically less, salverform, white; fruit a one-seeded white fleshy drupe **Vallesia**
- 10. Flowers much longer than 1.5 cm, funnelform or salverform, white, yellow, or red; fruit a many-seeded follicle or 1–4 seeded fleshy drupe 11
- 11 (10). Flowers salverform, white, red, or yellowish; corolla orifice small; calyx without colleters; fruit a thick, stout, dry follicle; seeds winged **Plumeria**
- 11. Flowers funnelform (salverform in *T. abouai* (L.) A. DC.), bright yellow or creamy; corolla orifice large; calyx with colleters; fruit a triangulate fleshy drupe; seeds ovoid **Thevetia**
- 7. Leaves opposite or whorled 12
- 12 (7). Leaves opposite; calyx with colleters; anther bases prolonged into a fork; seeds with arils 13
- 13 (12). Inflorescence of 1–4(–10) flowers; corolla large and showy, tube (8–)15–30 mm long, funnelform, cream-colored or yellow; anthers included; sepals mostly leafy and not clasping the corolla base **Stemmadenia**
- 13. Inflorescence of 10–50 flowers; corolla small, tube 7–16 mm long, salverform, white; anthers exerted or inserted; sepals mostly thick and clasping the corolla base. **Tabernaemontana**
- 12. Leaves whorled (occasionally opposite); calyx without colleters; anther bases obtuse or prolonged into a fork (*Allamanda*); seeds without arils 14

- 14 (12). Anther bases prolonged into a fork; corolla large, to 8 cm long, bright yellow; leaves without glands along the petiole; ovary 1; styles not cleft at base; fruit a spiny capsule; seeds winged; occasionally naturalized species **Allamanda cathartica** L.
14. Anther bases obtuse; corolla small, to 2 cm long, white; leaves with or without glands along the petiole; ovaries 2; styles cleft at base; fruit not spiny; seeds not winged; native 15
- 15 (14). Petiole scattered with many colleters along its length; fruit a fleshy reddish-brown drupe; seeds glabrous **Rauvolfia**
15. Petiole without colleters; fruit a linear dry follicle; seeds ciliate along the margin **Alstonia**
1. Anthers fused to pistil head, bases prolonged into a fork (obtuse in *Fernaldia*); aestivation of corolla bud to the right; plants typically scandent (herbaceous in *Apocynum*; shrubby in *Nerium*, *Telosiphonia*, *Mandevilla karwinskii* (Müll. Arg.) Hemsl.); leaves opposite (whorled in *Nerium*), never alternate; fruit a dry follicle, seeds apically comose 16
- 16 (1). Erect herbaceous perennial to 0.9 m high; flowers small, 5–12 mm long, campanulate-tubular; corolla with internal scales at base of tube; pollen in tetrads; northern Mexico **Apocynum**
16. Shrubs or lianas, occasionally suffruticose herbs (*Telosiphonia*); flowers typically large and showy, 10–70 mm long (3–9 mm in *Echites* subg. *Pseudechites*, *Forsteronia* and *Thenardia*), funnelform or salverform; corolla without internal scales at base of tube; pollen granular; throughout Mexico 17
- 17 (16). Pistil head pentagonal (Fig. 1b); leaves with 2–4 colleters at apex of petiole above, bases cordate (Fig. 2) or rounded; “*Mandevilla*” complex 18
- 18 (17). Anthers with pubescent apical filamentous appendages; filaments long and pronounced; leaves with domatia in axils of veins beneath; calyx large and showy, with burgundy margins **Tintinabularia mertonii** Woodson
18. Anthers without apical appendages; filaments reduced, anthers essentially sessile; leaves without domatia in axils of veins below; calyx small and green 19
- 19 (18). Inflorescence compound, branched (Fig. 3b); leaf base rounded **Mesechites trifida** (Jacq.) Müll. Arg.
19. Inflorescence simple and unbranched (Fig. 3a), or reduced to a solitary flower (*Telosiphonia*); leaf base cordate (Fig. 2) or rounded 20
- 20 (19). Lianas or suffrutescent herbs; leaves with (subg. *Exothostemon*) or without (subg. *Mandevilla*) glands along midrib of the upper surface; inflorescences many flowered; flowers diurnal, red, yellow, or white **Mandevilla**
20. Suffrutescent herbs, never twining; leaves without glands along midrib of the upper surface; inflorescences reduced to a solitary flower; flowers vespertine, white **Telosiphonia**
17. Pistil head fusiform (Fig. 1a); leaves without colleters at apex of peti-

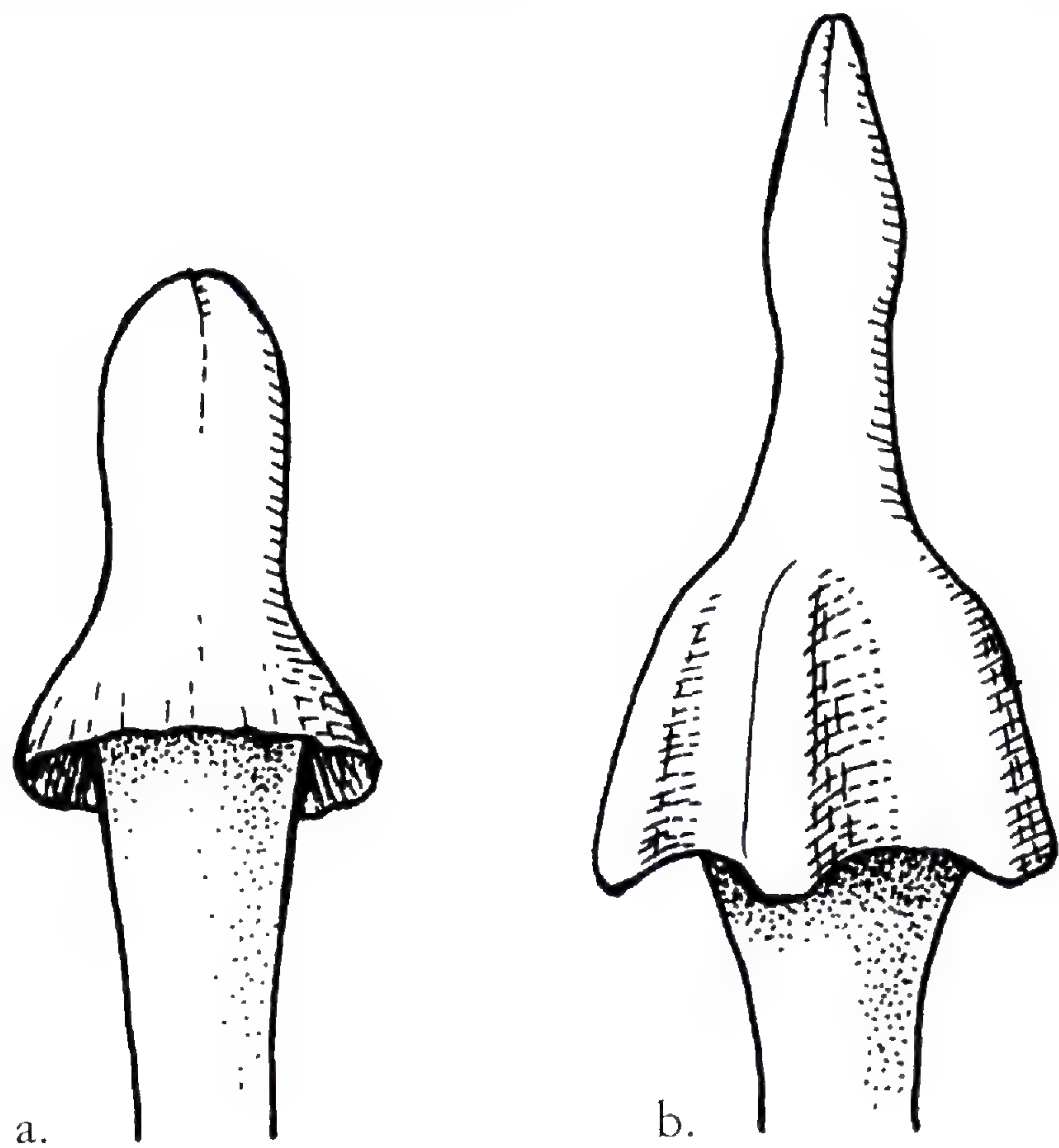


FIG. 1. Representative pistil heads: A. “*Echites*” complex. B. “*Mandevilla*” complex.

ole above, or if colleters present then solitary and leaves with domatia in the axils of veins below (*Forsteronia*), bases rounded; “*Echites*” complex 21

21 (17). Anthers with apical filamentous appendages 4–5 mm long; leaves opposite or whorled 22

22 (21). Anther appendages pubescent; shrubs; corolla with petaloid appendages within; leaves whorled (occasionally opposite); seed covered by short hairs, margins pubescent; cultivated **Nerium oleander** L.

22. Anther appendages glabrous; lianas; corolla without petaloid appendages; leaves opposite; seed glabrous, coma rostrate; native and occasionally cultivated **Pentalinon andrieuxii** (Muell. Arg.) Hansen & Wunderlin

21. Anthers without apical filamentous appendages; leaves opposite 23

23 (21). Sepals ovate, 5–20 mm long, 2–10 mm wide (Fig. 4b,c,d) 24

24 (23). Plants yellowish-villous or glabrous; corolla salverform; anthers exerted or included; corolla mouth with a thickened annulus; petioles subtended by pectinate glands **Prestonia**

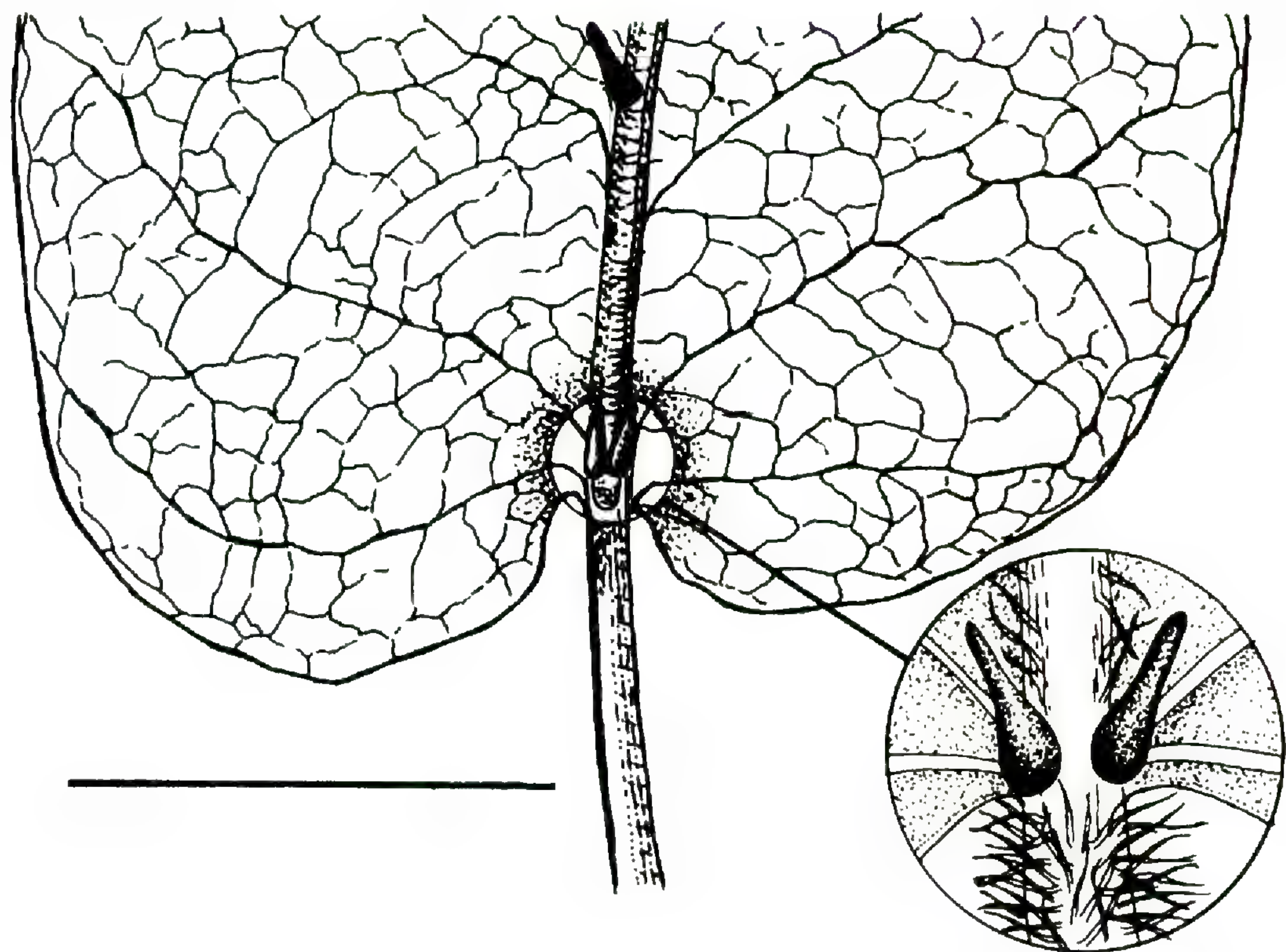


FIG. 2. Representative leaf of “*Mandevilla*” complex, showing subcordate base and position of colleters. Bar equals 5 mm.

- 24. Plants glabrous; corolla funnelform; anthers included; corolla mouth not thickened; petioles without pectinate glands 25
- 25 (24). Inflorescence of 1–4 flowers; sepals not imbricate (Fig. 4c); calycine colleters absent; anther body glabrous, the tip pubescent **Rhabdadenia biflora** (Jacq.) Müll. Arg.
- 25. Inflorescence of 5–10 flowers; sepals imbricate (Fig. 4d); calycine colleters present, alternate the sepals; anther body pubescent, the tip glabrous **Odontadenia caudigera** Woodson
- 23. Sepals triangular to narrowly triangular, 0.5–5.0 mm long, 0.5–1.0 mm wide (Fig. 4a) 26
- 26 (23). Corolla 3–5 mm long, tube 0.5–2.0 mm long; anther tip exserted 27
- 27 (26). Inflorescence thyriform; leaves inconspicuously glandular at base of midrib above, domatia in axils of veins beneath; colleters alternate calyx lobes; follicles free **Forsteronia**
- 27. Inflorescence a subumbellate cyme; leaves eglandular above and without domatia below; colleters opposite calyx lobes; follicles fused throughout their length **Thenardia**

- 26. Corolla 7–65 mm long, tube 7–40 mm long (4–5 mm in *Fernaldia asperoglottis* Woodson); anthers exserted (*Laubertia*) or included 28
- 28 (26). Anthers exserted; corolla tube twisted, mouth with a thickened annulus; sepals without colleters; ovary densely pubescent **Laubertia contorta** (Mart. & Gal.) Woodson
- 28. Anthers included; corolla tube straight or twisted, mouth not thickened; sepals with a solitary episepalous colleter; ovary glabrous 29
- 29 (28). Corolla funnellform (Fig. 5c), 35–50 mm long, tube straight; corolla lobes villous **Fernaldia**
- 29. Corolla salverform (Fig. 5a), 40–65 mm long (subg. *Echites*) or 7–9 mm long (subg. *Pseud-echites*), tube straight (twisted in *E. umbellata* Jacq.); corolla lobes glabrous (villous in *E. woodsoniana* Monac.) **Echites**

ALPHABETICAL LISTING OF THE NEW WORLD MEXICAN GENERA OF APOCYNACEAE

Allamanda L., Mant. 214. 1771.

TYPE SPECIES: *Allamanda cathartica* L.
 Represented by one species in Mexico.
 Fallen, M.E. 1985. The gynoeceal development and systematic position of *Allamanda* (Apocynaceae). Amer. J. Bot. 72:572–579.
 Sakane, M. and G. J. Sheperd. 1987. Uma revisão do gênero *Allamanda* L. (Apocynaceae). Rev. Brasil Bot. 9:125–149. [illus. and maps]
Note: *Allamanda* is native to South America and is represented in Mexico by the cultivated species *A. cathartica* L.

Alstonia R. Br., Mem. on Asclepiad. 64. 1810. (nom. cons.).

Type Species: *Echites scholaris* L.
Tonduzia Pittier, Contr. U.S. Natl. Herb. 12:103. 1908.
 Represented by two species in Mexico.
 Gentry, A. 1983. *Alstonia* (Apocynaceae): another palaeotropical genus in Central America. Ann. Missouri Bot. Gard. 70:206–207. [reduction of *Tonduzia* to *Alstonia*]
 Morales, J.F. 1995 Evaluación del género *Alstonia* (Apocynaceae en Centro América). Phytologia 78:192–194.

Amsonia Walt., Fl. Car. 98. 1788.

TYPE SPECIES: *Amsonia tabernaemontana* Walt.
 Represented by four species in Mexico.
 McLaughlin, S.P. 1982. A revision of the southwestern species of *Amsonia* (Apocynaceae). Ann. Missouri Bot. Gard. 69:336–350. [illus. and maps]

Apocynum L., Sp. Pl. 213. 1753.

TYPE SPECIES: *Apocynum cannabinum* L.
 Represented by two species in Mexico.
 Woodson, R.E., Jr. 1930. Studies in the Apocynaceae I. A critical study of the Apocynoideae (with special reference to the genus *Apocynum*). Ann. Missouri Bot. Gard. 17:1–212. [maps]



FIG. 3. Inflorescence: A. *Mandevilla subsagittata* (R. & P.) Woodson. B. *Mesechites trifida* (Jacq.) Müll. Arg., scanned from *McGregor* 930 (TEX), and *Contreras* 2303 (TEX), respectively.

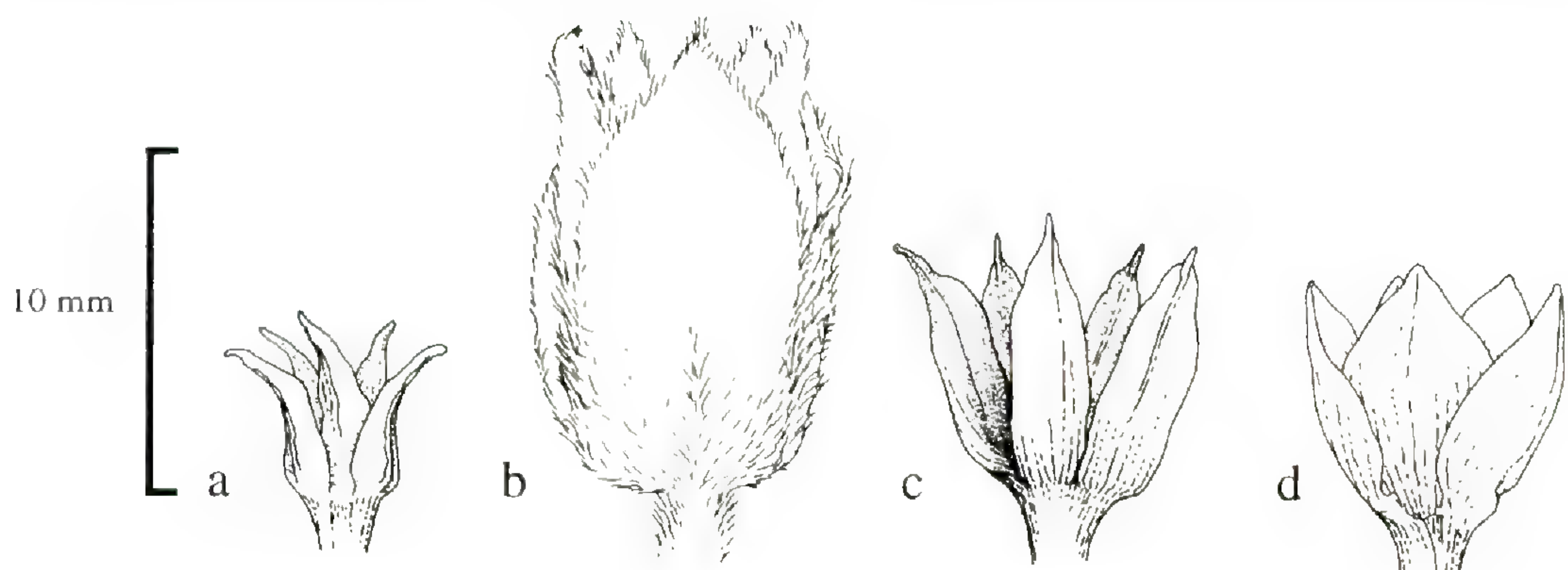


FIG. 4. Representative sepals: A. *Echites yucatanensis* Millsp. B. *Prestonia mexicana* Donn. Smith. C. *Rhabdadenia biflora* (Jacq.) Müll. Arg. D. *Odontadenia caudigera* Woodson.

Aspidosperma C. Martius & Zucc., *Flora* 7(1) (Beil.) 135. 1824 (nom. cons.).

TYPE SPECIES: *Aspidosperma tomentosum* C. Martius & Zucc.

Cufodontia Woodson, *Arch. Bot. Sist.* 10:38. 1934.

Represented by two species in Mexico.

Marcondes-Ferreira, W. 1989. *Aspidosperma* C. Martius & Zucc. nom. cons. (Apocynaceae): Estudos Taxonomicos. Doctoral Thesis, Universidade Estadual de Campinas.

Woodson, R.E., Jr. 1951. Studies in the Apocynaceae VIII. An interim revision of the genus *Aspidosperma* C. Martius & Zucc. *Ann. Missouri Bot. Gard.* 38:119–206. [reduction of *Cufodontia*; illus.]

Cameraria L., *Sp. Pl.* 210. 1753.



FIG. 5. Corolla and bud: A–B. *Echites yucatanensis* Millsp. C–D. *Fernaldia pandurata* (A. DC.) Woodson. Scanned from *Lundell 7455* (TEX), and *Williams 95-90* (TEX), respectively. **Note:** After drying, the flowers turn yellow (as seen here), however, in the field they are in fact white.

TYPE SPECIES: *Cameraria latifolia* L.

Represented by one species in Mexico.

Woodson, R.E., Jr. 1938. *Cameraria*. In: N.L. Britton, W.A. Murrill, and J.H. Barnhart, eds. *Apocynaceae*. N. Amer. Fl. 29:120–121.

Note: *Cameraria* was unknown from Mexico at the time of its last revision (Woodson, cited above). It has recently been collected in the Yucatan peninsula, where represented by *C. latifolia* L.

Representative specimens. **Campeche:** 4 km W of Conhuas, 98 km along road to Escarcega, 18 Aug 1983, *Cabrera 5353* (MEXU, MO). **Tabasco:** 2 km of La N-25, along La W-0 on the road to N-20, near Un Drene, Balancan, 13 Oct 1975, *Menendez 296* (MEXU). **Quintana Roo:** Mpio. Carrillo Puerto, Sian Ka'an Biosphere Reserve, 15–20 km N of Carrillo Puerto (19° 50' N; 87° 40' W), 2 Nov 1984, *Neill 5752* (MO). **Veracruz:** Orizaba, 17 Aug 1940, *Miranda 625* (MEXU). **YUCATAN:** 15 km NW of Humucma, along road Merida-Sisal, 20 Jul 1985, *Cabrera 9097* (MO).

Cascavela Raf. = **Thevetia**

Cufodontia Woodson = **Aspidosperma**

Echites P. Browne, *Civ. Nat. Hist. Jamaica* 182. 1756.

TYPE SPECIES: *Echites umbellata* Jacq.

Represented by five species in Mexico.

Monachino, J. 1959. A new *Echites* from Mexico. *Bull. Torrey Bot. Club* 86:245–247. [description of *Echites woodsoniana* Monac.; illustration; Michoacan]

Morales, J.F. 1996. A reevaluation of the genus *Echites* (Apocynaceae). *Brittonia* (in press).

Woodson, R.E., Jr. 1936. Studies in the Apocynaceae IV. *Ann. Missouri Bot. Gard.* 23:169–438. [*Echites* 217–252]

Fernaldia Woodson, *Ann. Missouri Bot. Gard.* 19:48. 1932.

TYPE SPECIES: *Echites pandurata* A. DC.

Represented by two species in Mexico.

Morton, J. E., Alvarez, E., and Quiñonez, C. 1990. Loroco, *Fernaldia pandurata* (A. DC.) Woodson (Apocynaceae): a popular edible flower of Central America. *Econ. Bot.* 44:301–310.

Woodson, R.E., Jr. 1932. New or otherwise noteworthy Apocynaceae of tropical America II. *Ann. Missouri Bot. Gard.* 19:48–49. [erection of *Fernaldia*; illustration]

_____. 1936. Studies in the Apocynaceae IV. *Ann. Missouri Bot. Gard.* 23:169–438. [*Fernaldia* 260–263]

_____. 1939. New or otherwise noteworthy Apocynaceae of tropical America VI. *Ann. Missouri Bot. Gard.* 26:96–97. [description of *Fernaldia asperoglottis* Woodson; Guerrero]

Note: *Fernaldia* is often confused with *Echites* subgenus *Echites*, it can be readily distinguished from subg. *Echites* by its funnelform corolla (Fig. 5c).

Forsteronia G. Mey., *Prim. Fl. Esseq.* 133. 1818.

TYPE SPECIES: *Echites spicata* Jacq.

Represented by four species in Mexico.

Hansen, B.F. 1985. A monographic revision of *Forsteronia* (Apocynaceae). Doctoral Thesis. University of South Florida. [illus. and maps]

Haplophyton A. DC., *Prodr.* 8:412. 1844.

TYPE SPECIES: *Haplophyton cimidum* A. DC.

Represented by two species in Mexico.

Nelson, C. 1994. *Haplophyton cimidum* A. DC. versus *Haplophyton cinereum* (A. Rich.) Woodson (Apocynaceae). *Fontqueria* 40:49–52.

Williams, J.K. 1995. Miscellaneous notes on *Haplophyton* (Apocynaceae: Plumerieae: Haplophytinae). *Sida* 16:469–475. [maps]

Laubertia A. DC., *Prodr.* 8:486. 1844.

TYPE SPECIES: *Laubertia boissierii* A. DC.

Streptotrachelus Greenman, *Proc. Amer. Acad. Arts* 32:298. 1897.

Represented by one species in Mexico.

Woodson, R.E., Jr. 1936. Studies in the Apocynaceae IV. *Ann. Missouri Bot. Gard.* 23:169–438. [*Laubertia* 370–375]

Macrosiphonia Müll. Arg. subg. *Telosiphonia* Woodson = **Telosiphonia**

Mandevilla Lindl., *Edwards's Bot. Reg.* 26:t. 7. 1840.

TYPE SPECIES: *Mandevilla suaveolens* Lindl.

Represented by approximately 18 species in Mexico.

Lundell, C.L. 1942. Studies of American Spermatophytes II. *Contr. Univ. Mich. Herb.* 7:46–47. [description of *Mandevilla mollis* Lundell; Chiapas]

Woodson, R.E., Jr. 1933. Studies in the Apocynaceae IV. *Ann. Missouri Bot. Gard.* 20:605–790. [*Mandevilla* 645–777]

Note: *Mandevilla* is often confused with *Echites*, it can be readily distinguished from *Echites* by its colleters along the petiole apex (Fig. 2) and its pentagonal pistil head (Fig. 1b).

Mesechites Müll. Arg., *Fl. Bras.* 6:150. 1860.

TYPE SPECIES: *Mesechites mansoana* A. DC.

Represented by one species in Mexico.

Woodson, R.E., Jr. 1933. Studies in the Apocynaceae IV. *Ann. Missouri Bot. Gard.* 20:605–790. [*Mesechites* 629–645]

Note: *Mesechites* is often confused with *Mandevilla*, it can be readily distinguished from *Mandevilla* by its branching inflorescence (Fig. 3b).

Odontadenia Benth., J. Bot. (Hooker) 3:242. 1841.

TYPE SPECIES: *Odontadenia spicata* Benth.

Represented by one species in Mexico.

Woodson, R.E., Jr. 1935. Studies in the Apocynaceae IV. Ann. Missouri Bot. Gard. 22:153–306. [*Odontadenia* 270–306]

_____. 1936. Studies in the Apocynaceae IV. Ann. Missouri Bot. Gard. 23:169–438. [*Odontadenia* 384–386; description of *Odontadenia caudigera* Woodson]

Note: *Odontadenia* was unknown from Mexico at the time of its last revision (Woodson, cited above). It has recently been collected in the state of Chiapas, Mexico, where represented by the species *O. caudigera* Woodson.

Representative specimens. **Chiapas:** Mpio. Ocosingo, in Ejdo El Piró, 15 km E of Chajul, on the road to Boca Lacantum, 16 Apr 1986, *Martínez 18212* (MEXU).

Pentalinon Voigt, Hortus Suburb. Calcut. 523. 1845.

TYPE SPECIES: *Echites suberectum* Jacq.

Urechites Müll. Arg., Bot. Zeitung 18:22. 1860.

Represented by one species in Mexico.

Hansen, B.F., and R.P. Wunderlin. 1986. *Pentalinon* Voigt, an earlier name for *Urechites* Müll. Arg. (Apocynaceae). Taxon 35:166–168.

Peschiera A. DC. = **Tabernaemontana**

Plumeria L., Sp. Pl. 209. 1753.

TYPE SPECIES: *Plumeria rubra* L.

Represented by approximately two species in Mexico.

Bandyopadhyaya, M., and P. C. Dutta. 1986. Comparative anatomy of different species of *Plumeria*. Bull. Bot. Soc. Bengal 40:59–66.

Woodson, R.E., Jr. 1938. An Evaluation of the Genera *Plumeria* L. and *Himatanthus* Willd. Ann. Missouri Bot. Gard. 25:189–224.

Plumeriopsis Rusby & Woodson = **Thevetia**

Prestonia R. Br., on Asclepiad. 58. 1810 (nom. cons.).

TYPE SPECIES: *Prestonia tomentosa* R. Br.

Represented by approximately three species in Mexico.

Gentry, A. 1983. A new combination for a problematic Central American Apocynaceae. Ann. Missouri Bot. Gard. 70:205–206. [transfer of *Echites woodsoniana* Monac. to *Prestonia*]

Williams, L.O. 1968. Tropical American Plants, IX. Fieldiana, Bot. 31:402–403. [description of *Prestonia grandiflora* L. O. Wms.; Chiapas]

Woodson, R.E., Jr. 1936. Studies in the Apocynaceae IV. Ann. Missouri Bot. Gard. 23:169–438. [*Prestonia* 276–367]

Note: *Prestonia* is subdivided into four sections. Two sections (*Coalitae* and *Acutifoliae*) are not represented in Mexico, they are characterized by having small and inconspicuous sepals similar to those of *Echites* (Fig. 4a). The other two sections (*Annulares* and *Tomentosae*) are represented in Mexico by one or two species each, they are characterized by large foliaceous sepals (Fig. 4b). Gentry (cited above) transferred *Echites woodsoniana* Monac. to *Prestonia*, relating it to members of sect. *Coalitae*. Because of the confusing nature of generic delimitations in the Apocynaceae, and the lack of a corolla annulus in *E. woodsoniana*, he was not confident of his transfer. I am inclined to

maintain the species in *Echites* given that at present no other Mexican species of *Prestonia* have inconspicuous sepals and because of the taxon's lack of a corolla annulus and pectinate glands at the base of the petiole.

Rauwolfia L., Sp. Pl. 208. 1753.

TYPE SPECIES: *Rauwolfia tetraphylla* L.

Rauwolfia Gleditsch, Syst. 212. 1764 (orth. var.).

Represented by two species in Mexico.

Rao, A.S. 1956. A revision of *Rauwolfia* with particular reference to the American species. Ann. Missouri Bot. Gard. 43:253–355. [illus. and maps]

Rauwolfia Gleditsch = **Rauwolfia**

Rhabdadenia Müll. Arg., Fl. Brasil 6:173. 1860.

TYPE SPECIES: *Rhabdadenia poblii* Müll. Arg.

Represented by one species in Mexico.

Woodson, R.E., Jr. 1936. Studies in the Apocynaceae IV. Ann. Missouri Bot. Gard. 23:169–438. [*Rhabdadenia* 205–211]

Stemmadenia Benth., Bot. Voyage Sulphur 124. 1845.

TYPE SPECIES: *Stemmadenia glabra* Benth.

Represented by six species in Mexico.

Allorge, L. 1985. Monographie des Apocynacées-Tabernaemontanoïdées Américaines, Morphologies, Systématique, Chimio-taxonomie. Mém. Mus. Natn. Hist. Nat. Paris, n.s. 30:1–216. [illus.]

Leeuwenberg, A.J.M. 1994. Index of exsiccatae of *Tabernaemontana*, the New World species, and *Stemmadenia*. Wageningen, Netherlands: Dept. of Plant Taxonomy, Wageningen Agricultural University.

_____. 1994. A revision of *Tabernaemontana*. Two. The New World species and *Stemmadenia*. The Royal Botanic Gardens, Kew, Richmond. [illus. and maps]

Streptotrachelus Greenman = **Laubertia**

Tabernaemontana L., Sp. Pl. 210. 1753.

TYPE SPECIES: *Tabernaemontana citrifolia* L.

Peschiera A. DC., Prodr. 8:360. 1844.

Represented by three species in Mexico.

Allorge, L. 1985. Monographie des Apocynacées-Tabernaemontanoïdées Américaines, Morphologies, Systématique, Chimio-taxonomie. Mém. Mus. Natn. Hist. Nat. Paris, n.s. 30:1–216. [illus.]

Leeuwenberg, A.J.M. 1994. Index of exsiccatae of *Tabernaemontana*, the New World species, and *Stemmadenia*. Wageningen, Netherlands: Dept. of Plant Taxonomy, Wageningen Agricultural University.

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Telosiphonia (Woodson) Henrickson, Aliso 14:179–195. 1995 [1996]

TYPE SPECIES: *Echites hypoleuca* Benth.

Macrosiphonia Müll. Arg. subg. *Telosiphonia* Woodson, Ann. Missouri Bot. Gard. 20:778. 1933.

Represented by six species in Mexico.

Henrickson, J. 1995 [1996]. Studies in *Macrosiphonia* (Apocynaceae): Generic recognition of *Telosiphonia*. Aliso 14:179–195. [transfer of North American *Macrosiphonia* to *Telosiphonia*; illus. and maps]

Note: It has been recently suggested by Henrickson (cited above) that *Macrosiphonia* is at present polyphyletic: the North American species (subg. *Telosiphonia*) having no relation to the South American ones (subg. *Macrosiphonia*). Henrickson has proposed the transfer of the North American species to the newly erected genus *Telosiphonia*.

Thenardia Kunth, Nova Gen. Sp. 3:209. 1819.

TYPE SPECIES: *Thenardia floribunda* Kunth

Represented by three species in Mexico.

Woodson, R.E., Jr. 1936. Studies in the Apocynaceae IV. Ann. Missouri Bot. Gard. 23:169–438. [*Thenardia* 271–276]

Williams, J.K. 1995. A new species of *Thenardia* with notes on the genus. Brittonia 47:403–407. [description of *Thenardia chiapensis* J. K. Williams; illus.; Chiapas]

Note: *Thenardia* is the only apocynaceous genus endemic to Mexico. Currently, there are five species recognized in *Thenardia*, however, recent evidence (Williams, in prep.) suggests that two of these, *T. gonolobies* Woodson and *T. tubulifera* Woodson, should be reduced to synonymy under *T. galeottiana* Baillon and *T. floribunda* Kunth, respectively.

Thevetia L., Opera Varia 212. 1758 (nom. cons.).

TYPE SPECIES: *Cerbera abouai* L.

Cascavela Raf., Sylva Tell. 162. 1838.

Plumeriopsis Rusby & Woodson, Ann. Missouri Bot. Gard. 24:11. 1937.

Represented by six species in Mexico.

Costa, E. de L. and C.G. Costa. 1980. Considerações sobre o fruto de *Plumeriopsis abouai* (L.) Rusby & Woodson (Apocynaceae). Rodriguésia 32(55):65–72.

Gensel, W.H. 1969 A revision of the genus *Thevetia* (Apocynaceae). Masters Thesis. University of Connecticut. [illus. and maps]

Williams, J.K. 1996. A new combination in *Thevetia* (Apocynaceae). Sida 17:185–190. [elevation of *T. peruviana* (Pers.) K. Schum. var. *pinifolia* Standl. & Steyerm. to species; maps; Michoacan]

Woodson, R.E., Jr. 1937. New or otherwise noteworthy Apocynaceae of tropical America V. Ann. Missouri Bot. Gard. 24:11–12. [erection of *Plumeriopsis*]

Note: When Rusby and Woodson (Woodson 1937, cited above) described the monotypic *Plumeriopsis* (*P. abouai* (L.) Rusby & Woodson) they distinguished it from *Thevetia* on the basis of its baccate fruits (vs. drupaceous) and salverform corollas with reflexed lobes (vs. funnelform and spreading or erect). They reported that both genera had “brilliant red” mesocarps. My observations in the field, however, indicate that *Plumeriopsis* has red fruits and that the fruits of *Thevetia* are green when immature and blackish when mature. *Plumeriopsis* shares all other morphological (phyllotaxy, stigma and stamen) features with *Thevetia* and I treat it is a synonym of *Thevetia*.

Tintinnabularia Woodson, Ann. Missouri Bot. Gard. 23:387. 1936.

TYPE SPECIES: *Tintinnabularia mortonii* Woodson

Represented by one species in Mexico.

Woodson, R.E., Jr. 1936. Studies in the Apocynaceae IV. Ann. Missouri Bot. Gard. 23:169–438. [*Tintinnabularia* 387–391; erection of *Tintinnabularia*; illustration]

Note: *Tintinnabularia* is an extremely beautiful and elusive monotypic genus, which has been rarely collected. I took a field trip (Summer 1995) to the two most recent collection sites from Chiapas, Mexico (see below) in order to collect fruits, which are at present unknown. However, as a result of the area being converted into grazing land, the plant was not found. The native vegetation was replaced by weedy forbs and other adventive weeds.

Representative specimens. **Chiapas:** Municipio of Solosuchiapa, steeped walled canyon along a fast moving stream with seasonal Evergreen Forest, 2–4 km below Ixhuatan along road to Pichucalco, 8 May 1973, *Breedlove* 34900 (TEX); Municipio of La Trinitaria, slopes with Montane Rain Forest, E of Laguna Tzikaw, Monte Bello National Park, 1300 m, 13 May 1973, *Breedlove* 35191 (TEX).

Tonduzia Pittier = **Alstonia**

Urechites Müll. Arg. = **Pentalinon**

Vallesia Ruíz & Pavón, Fl. Peruv. Prodr. 28. 1794.

TYPE SPECIES: *Rauvolfia glabra* Cav.

Represented by approximately four species in Mexico.

Woodson, R.E., Jr. 1938. *Vallesia*. In: N.L. Britton, W.A. Merrill, and J.H. Barnhart, eds. Apocynaceae. N. Amer. Fl. 29:138–141.

Note: Woodson (cited above) recognized six species of *Vallesia* in Mexico. Preliminary research suggests, however, that *V. baileyana* Woodson and *V. conzattii* Standley should be treated as synonyms of *V. lanciniata* Brandl., reducing the number of species in Mexico to four. Further examination is needed, however, before a definitive treatment can be resolved.

ADDITIONAL GENUS

Trachelospermum Lemaire, Jard. Fleur. 1:pl. 61. 1851.

TYPE SPECIES: *Rhynchospermum jasminoides* Lindl.

Note: *Trachelospermum jasminoides* (Lindl.) Lemaire, a native of Asia, is occasionally cultivated in Mexico. The genus is represented by one species in North America, *T. difforme* (Walt.) A. Gray, but this species has not been reported from Mexico. *Trachelospermum* is distinguished by its scandent habit, opposite leaves, fragrant white salverform corollas (5–6 mm long), and connivent anthers. The genus has not become naturalized in Mexico. Below is the only specimen from Mexico that I have seen in any of the herbaria examined.

Representative specimens. **Sonora:** Hermosilo, cultivated, 6 May 1922, *Malsallago* 503 (MEXU).

Author's note: Scanned images of representative herbarium specimens of selected Apocynaceae species in Mexico, with distribution maps, are available on the World Wide Web. These images can be found on the home page of the Plant Resources Center at the University of Texas (<http://www.utexas.edu/ftp/depts/prc/>).

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BOOK REVIEW

STATES, JACK. S. 1990. **Mushrooms and Truffles of the Southwest.** (ISBN 0-8165-1192-6. pbk). The University of Arizona Press, 1230 N Park Ave., Suite 102, Tucson, AZ 85719, Price not given, 234 pp, 156 color photos.

This is the first publication that covers such a broad range of fungi for southwestern United States according to the author. Coverage also includes the Myxomycetes and lichens, organisms usually not discussed or illustrated, along with traditional fungal groups such as mushrooms and their relatives. Southwestern geographically includes Arizona, New Mexico, and parts of Colorado, Utah, Nevada, California and northern Mexico. The natural history of mushrooms is emphasized by directing the reader to life zones and plant communities where species can be found. Life zones are illustrated by maps. Keys lead to descriptions and color illustrations for 156 of the major mushroom and truffle species. There are additional descriptions for 155 other species. A unique feature of this book is the inclusion of cross-references to assist in species identification. There are eight different cross-references for mushrooms that serve as field guides and one for lichens. There are no references for Myxomycetes.

Introductory topics include an excellent discussion of life zones of the Southwest. There is a picture key to the major groups of fungi based on black and white illustrations of fruiting bodies and also a narrative dichotomous key. The Basidiomycetes represent the largest treatment of fungi, covering 129 pages with keys to the families based on macroscopic characters, for example, spore print colors. Indeed, the book is written more for the amateur using nontechnical, easily understood characters to identify species. The format is very user friendly with color illustrations (4" × 2 1/2") grouped usually two to a page or sometimes one per page with the name of the species and species description on the same page. The habit color photographs are of excellent quality and oriented to show the necessary key characters. There is a comments section for each species that discusses the edibility or toxic properties, ecology, and special morphological features. The Ascomycetes are represented by 32 pages and 18 pages are devoted to the tuberlike Ascomycetes and Basidiomycetes (the truffles and false truffles). This section of the book is especially valuable since this group of fungi is usually absent from field guides. However, a combination of the small size of these underground fungi, lack of bright coloration and distinctive morphology, and failure to stand out against a drab background of soil, litter, or man-made surfaces makes it difficult to clearly discern surface features and color. Eight pages are devoted to an assortment of lichens on rocks and branches of trees. There is a glossary of 65 terms defined. The bibliography is not extensive, consisting of the cross-references, six additional field guides, and suggested readings that mentions four books. Anyone interested in the fungi of the southwestern region of the United States will find this book a welcomed addition to their bookshelf. —*Harold W. Keller, Research Associate, BRIT.*

LAS COMUNIDADES VEGETALES EN LA ISLA SOCORRO, MEXICO

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ABSTRACT

In this work the different plant communities on Socorro Island are described and delimited in a map of vegetation; also, the distribution of the endemic species in the different plant communities is analysed. The identification and mapping of the different plant communities was based in four trips to the island which included plant collecting, walk arounds and overviews by airplane, aerial photos 1:70,000 were revised as guide. Most of the plant communities and nomenclature used in this work agree with those proposed by earlier descriptions. Six plant communities (prairie, evergreen tropical forest, mixed scrub, *Croton* scrubland, grassland, and coastal groups) are described with data about their area and dominant species. The eroded area, induced by overgrazing of the domestic sheeps which since 1869 inhabits the island, is also considered in the mapping, it covers about 15% of the total surface. On 210 km², Socorro Island counts with 116 species of native vascular plants, plus 46 naturalized.

RESUMEN

En este trabajo se describen y delimitan los diferentes tipos de vegetación de la isla Socorro, se presenta un mapa de las unidades de vegetación, se analizan la distribución de las especies endémicas y de las formas de vida en los diferentes tipos de vegetación, así como la riqueza específica en cada una de éstas. Para la identificación y cartografiado de las diferentes agrupaciones vegetales se realizaron cuatro viajes a la isla, durante los cuales se hicieron recorridos por tierra y por aire, también se revisaron fotos aéreas a escala 1:70,000. La nomenclatura de los tipos de vegetación aquí presentados son compatibles con los señalados por trabajos previos. En total se describen seis tipos de vegetación (pradera, bosque tropical perennifolio, matorral mixto, matorral de *Croton*, pastizal y agrupaciones costeras), proporcionándose la lista de las especies más comunes a cada una de ellas y delimitando su área de distribución. También se consideran las superficies erosionadas, que cubren actualmente alrededor del 15% de la isla, las cuales han sido inducidas por el sobrepastoreo del borrego doméstico, introducido en 1869. La flora de la isla Socorro (210 km² de superficie) está formada por 116 especies de plantas vasculares nativas y 46 introducidas recientemente.

INTRODUCCIÓN

El archipiélago de las Islas Revillagigedo (Islas Socorro, San Benedicto, Roca Partida y Clarión, Fig. 1) posee una posición geopolítica distintiva. El

archipiélago extiende el mar patrimonial mexicano en miles de km² en el pacífico occidental, lo que aumenta considerablemente el potencial de los recursos pesqueros dentro de la zona económica exclusiva. Sin embargo, la importancia de este archipiélago y particularmente de la isla Socorro, la mayor de las cuatro del sistema, radica no sólo en el aspecto político-económico, sino en su interesante biota, que es resultado de largos procesos evolutivos, caracterizados por un marcado aislamiento geográfico.

Sobre esta isla es posible hacer un historial en cuanto a las colectas de vegetales vasculares. La primera se ubica dentro de la segunda mitad de la década de 1830, a ésta siguieron muchas otras de naturalistas norteamericanos, apoyadas principalmente por la Academia de Ciencias de California, en especial resalta la exploración de Johnston (1931). Avanzado el presente siglo, se realizan varias expediciones lideradas por biólogos mexicanos. Entre las más importantes se encuentran la de la Universidad de Guadalajara (Medina 1957) y la de la Universidad Nacional Autónoma de México (Adem et al. 1960). En esta última el botánico a cargo, el Dr. Faustino Miranda, describió siete agrupaciones vegetales para la isla, siendo éste el primer intento al respecto.

Del conjunto de colectores de plantas en la isla, el Dr. Reid V. Moran es quien la ha explorado más intensivamente, a través de tres expediciones reunió alrededor de 400 ejemplares, hecho que le animó a estructurar la hasta ahora flora más actualizada (Levin y Moran 1989). Esta obra contó con la colaboración del personal del Centro de Investigaciones Biológicas del Noroeste (CIBNOR, herbario HCIB), que aportó duplicados de 180 ejemplares, 12 de los cuales correspondieron a nuevos registros.

En la presente contribución se propone una nomenclatura para las unidades de vegetación, se describen fisonómica y florísticamente los diferentes tipos de vegetación existentes en la isla, que se muestran en un mapa. Se hace también un análisis florístico y de formas de vida en relación con su distribución en las agrupaciones descritas.

MATERIAL Y MÉTODOS

a) Descripción de la Isla

Socorro forma parte de las cuatro islas del archipiélago Revillagigedo, en la costa centro-occidental de México, se localiza a 110°59'N y 18°46'W, aproximadamente a 480 km al sur de la península de Baja California y a 490 km al oeste de la costa de Colima (Adem 1960). Esta isla es la más grande del archipiélago, con una extensión aproximada de 210 km² y una altitud máxima de 1050 m en la cima del volcán Evermann, que establece una fisiografía concéntrica, cuyo eje es dicho volcán.

Geológicamente se considera una isla oceánica de edad incierta. Bohrson

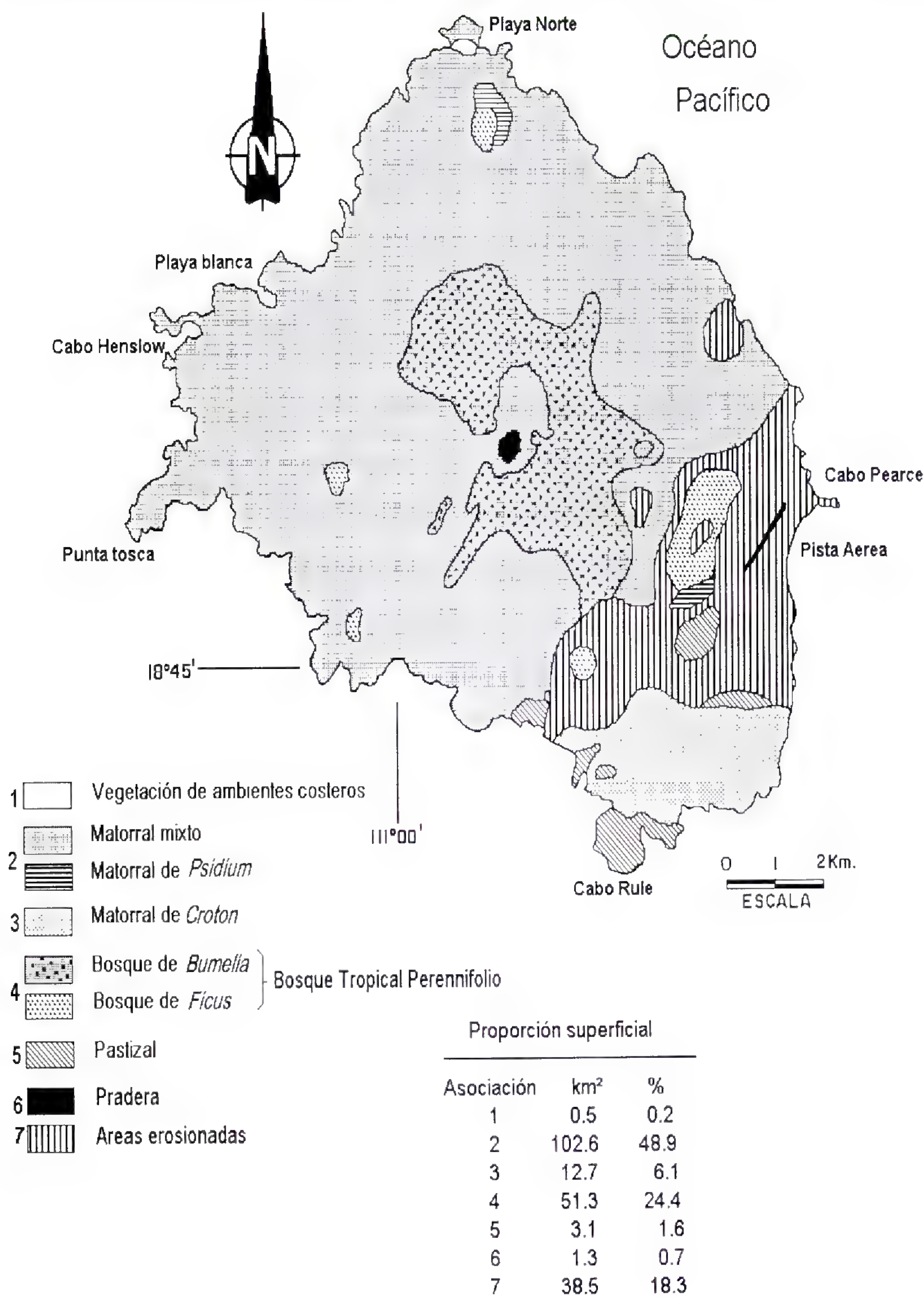


FIG. 1. Distribución de las 7 comunidades vegetales reconocidas en isla Socorro, Rev. Las superficies relativas de cada una se citan en el text. La vegetación de ambientes consteros bordea el litoral. Las áreas erosionadas contienen restos de la vegetacion primaria y en algunos sectores vegetación adventicia.

(1994) le asigna un origen volcánico de pocos millones de años. Blázquez (Adem et al. 1960) y Bryan (1949) la ubican en la transición mioceno-plioceno (unos 10–12 millones de años). Johnston (1931) cita que el sustrato subyacente es de origen continental pre-miocénico, además de que la batimetría de la región sugiere un origen continental.

De acuerdo con los datos climáticos disponibles en la única estación climatológica, ubicada al sur de la isla (10 m de altitud), Coria (1994) describe el clima de ese sector como BS_o(h)w(1); ésto es, árido, cálido, con régimen de lluvias de verano, la precipitación invernal aporta menos del 10% del total anual, siendo la oscilación térmica poco significativa. La temperatura media anual es de 24.6°C, mientras que la precipitación media anual es de 405 mm en ese sector. La zona norte de la isla es sensiblemente más húmeda; las superficies elevadas se encuentran frecuentemente cubiertas por neblina. Es factible que se presenten heladas en el invierno.

Por su posición geográfica subtropical, la isla se encuentra en la trayectoria de los ciclones que azotan la costa occidental de México durante el verano.

Los suelos de isla Socorro presentan características asociadas a materiales ígneos y se dividen en tres grandes áreas de distribución: en la zona norte, los suelos son jóvenes formados a partir de las coladas de lava de erupciones recientes, en la zona central han derivado de cenizas volcánicas y en la zona sur son suelos arcillosos y profundos (Maya et al. 1995).

b) Agrupaciones florísticas

Para la determinación de los tipos de vegetación, se realizaron cuatro estancias de trabajo de campo durante los meses de mayo, septiembre y diciembre de 1988 y febrero de 1990. Estas estancias comprendieron en total 26 días de actividad, durante los cuales se efectuaron recorridos a pie que permitieron coleccionar intensivamente.

La clasificación de los tipos de vegetación se hizo con base a un criterio fisonómico. El reconocimiento en avioneta y la observación de fotografía aérea permitieron delimitar cada agrupación designada; la fotografía usada fue cubierta por INEGI en 1976 escala 1:70,000. Visitas posteriores permitieron verificar y afinar las versiones previas de la delimitación de cada agrupación florística. Cabe aclarar que los recorridos a pie cubrieron una amplia superficie de la porción sur, pero la vertiente norte aún se encuentra inexplorada.

En este trabajo se hace referencia a cada unidad fisonómico-florística como un “tipo de vegetación.” En el caso de la evidente dominancia fisonómica de una o pocas especies se han empleado los nombres genéricos de los taxa característicos de esa vegetación.

RESULTADOS

a) Flora

De acuerdo con los registros de Levin y Moran (1989), la Isla Socorro cuenta con 116 especies nativas de plantas vasculares y 46 especies introducidas durante el presente siglo. Entre las nativas, se incluyen 5 especies aún no bien determinadas o no descritas, se trata de *Opuntia* sp., *Psidium* sp. (aff. *P. sartorianum*), *Passiflora* sp., *Rubus* sp., y una orquídea terrestre afín al género *Habenaria* (Levin, com. pers.). De las 116 especies nativas determinadas, 30 de ellas son endémicas de la isla a nivel específico (27) o infraespecífico (3), lo que representa el 26.7% de la flora insular. Es posible que la determinación de las 5 pendientes contribuya a elevar este nivel.

En el cuadro 1 se muestra la distribución en los diferentes tipos de vegetación de las 30 especies endémicas. La mayoría de las especies endémicas se encuentran en dos o más comunidades, pero ninguna de ellas se distribuye en todas, mientras que 13 parecen restringirse sólo a una de éstas.

En el cuadro 2 se muestra el espectro de las diferentes formas de crecimiento de las especies nativas que componen la flora de la isla. Es apreciable que las herbáceas congregan el mayor número de especies tanto en el grupo de nativas como en las de introducción reciente.

b) Tipos de vegetación

La fisonomía de la vegetación es en términos generales “tropical”; sin embargo, las diferencias altitudinales, topográficas, climáticas, de exposición y de suelo, han permitido el desarrollo de diferentes tipos de vegetación. De acuerdo con los recorridos por la isla y la fotointerpretación, se distinguen seis tipos, más una superficie considerable gravemente erosionada. A continuación se describen cada uno de éstos, en la Fig. 1 se delimitan estas mismas comunidades y se anota la superficie relativa.

1. Agrupaciones costeras

Ésta corresponde a lo que Miranda (Adem et al. 1960) denomina “Agrupación de halófitos costeros” y a lo que Levin y Moran (1989) señalan como “Shore.” Se estima que éstas ocupan una superficie de 0.5 km² lo que representan un 0.2% del área insular. Sus agrupaciones se encuentran distribuidas irregularmente a lo largo de la franja litoral rocosa, acantilados, playas y dunas costeras. Algunas de las especies representativas son:

<i>Canavalia rosea</i> (Sw.) DC.	<i>Cyperus howellii</i> O'Neill et Benedict Ayers
<i>Chamaesyce incerta</i> (T.S. Brandegees) Millsp.	<i>Cyperus ligularis</i> L.
<i>Conocarpus erecta</i> L.	<i>Heliotropium curassavicum</i> L.
<i>Cressa truxillensis</i> Kunth	<i>Hibiscus pernambucensis</i> Arruda
	<i>Hippomane mancinella</i> L.

CUADRO 1. Distribución de las 30 especies endémicas de Isla Socorro dentro de las comunidades vegetales consideradas.

Comunidad	Compartidas (17)	Restringidas (13)
Vegetación Costera	8	1
Matorral de <i>Croton</i>	5	1
Pastizal	3	1
Matorral Mixto	16	2
Bosque Tropical	13	4
Pradera	11	4

CUADRO 2. Espectro de las formas de crecimiento consideradas en este trabajo para la flora de Isla Socorro, Rev.

	Número total de especies	%	Flora Nativa	%	Flora Adventicia	%
Arboles	12	7.40	11	9.46	1	2.17
Arbustos	22	13.59	19	16.36	3	6.52
Herbáceas	104	64.20	65	56.01	40	86.97
Trepadoras	8	4.94	7	6.02	1	2.17
Epífitas	6	3.71	6	5.17	0	0
Hemiparásitas	2	1.23	2	1.71	0	0
Rastreras	7	4.32	6	5.17	1	2.17
Acuáticas	1	0.61	1	0.86	0	0
Total	162	100%	116	100%	46	100%

<i>Ipomoea pes-caprae</i> (L.) Sweet subsp. <i>brasiliensis</i> (L.) Ooststr	<i>Scaevola plumieri</i> (L.) Vahl
<i>Jouvea pilosa</i> (C. Presl.) Scribner	<i>Sida nesogena</i> I.M. Johnston
<i>Physalis mimulus</i> Waterf.	<i>Sorghastrum nutans</i> (L.) Nash in Small

2. Matorral de *Croton*

Corresponde al “matorral de *Croton*” de Miranda (Adem et al. 1960), y al “scrub” de Levin y Moran (1989). El componente dominante es *Croton masonii* I.M. Johnston, especie que durante la temporada de sequía, febrero-junio, pierde la totalidad de sus hojas. Esta comunidad ocupa alrededor de 12.6 km² (6.1%), encontrándose bien representada en la parte sur de la isla, desde el contorno de la franja costera hasta unos 250 m de altitud, se desarrolla sobre una extensa capa basáltica, con pendiente de leve a moderada. Existen manchones reducidos de esta vegetación hacia el norte y el oeste de la isla, en la misma franja altitudinal. Entre las especies allí existentes es posible distinguir:

<i>Abutilon californicum</i> Benth.	<i>Cordia curassavica</i> (Jacq.) Roemer et
<i>Bursera eppinata</i> (Rose) Engl.	Schultes

Cynanchum californicum (Benth.) Moran
Ipomoea triloba L.
Malvastrum americanum (L.) Torrey in
 Emory
Melochia pyramidata L.
Opuntia sp.
Pavonia hastata Cav.

Rhamnus sharpii M. et L.A. Johnston
Tournefortia hartwegiana Steudel
Viguiera chenopodina E. Greene
Waltheria indica L.
Zapoteca formosa (Kunth) H. Hern. subsp.
socorrensis (I.M. Johnst.) Levin, H.
 Hernández et Moran

3. Pastizal

Corresponde parcialmente a lo que Miranda (Adem et al. 1960) integró en la agrupación de halófitos costeros y Levin y Moran (1989) al “grassland.” Ocupa una extensión de unos 3.1 km² (1.6%), se distribuye en el extremo sur de la isla (Cabo Regla, Fig. 1), en lugares de pendiente moderada y lomeríos de escasa elevación. Si bien el terreno puede considerarse rocoso, ha logrado acumularse gran cantidad de suelo entre las mismas rocas permitiendo así el establecimiento de estos vegetales. En esta vegetación dominan las gramíneas, tales como: *Eragrostis tenella* (L.) P. Beauv. ex Roemer & Schultes, *Heteropogon contortus* P. Beauv. ex Roemer & Schultes, *Paspalum longum* Chase in I.M. Johnston, *Rhynchelytrum repens* (Willd.) Hubb., y *Schizachyrium sanguineum* var. *sanguineum* (Retz.) Alston.

Cabe señalar que el sector naval fue establecido permanentemente hacia finales de la década de los años cincuenta sobre esta agrupación florística; en consecuencia, una importante superficie de la misma, ubicada dentro del área de influencia de las instalaciones militares, ha sido alterada. En décadas pasadas se introdujo el “zacate buffel,” *Cenchrus ciliaris* L. y *C. myosuroides* Kunth in Humb. Especies acompañantes son:

Amaranthus palmeri S. Watson
Aristida adscensionis L.
Cenchrus myosuroides Kunth in Humb.
Chamaesyce anthonyi (T.S. Brandegees)
 Levin

Chamaesyce hirta (L.) Millsp. var. *hirta*
Waltheria indica L.
Zapoteca formosa (Kunth) H. Hern. subsp.
socorrensis (I.M. Johnst.) Levin, H.
 Hernández et Moran

4. Matorral mixto

El matorral mixto, corresponde al “matorral de *Dodonaea viscosa* Jacq.” de Miranda (Adem et al. 1960) y al “scrub” de Levin y Moran (1989). Esta comunidad ocupa la mayor superficie en la isla, cubre aproximadamente 102.7 km² (48.9%) desde el nivel del mar hasta 950 m de elevación en algunos sitios; sin embargo, la mayor parte de esta vegetación se distribuye por las partes baja y media de las zonas centro y norte. El matorral mixto se desarrolla sobre suelos pedregosos con pendientes de moderadas a pronunciadas. Esta comunidad vegetal se compone principalmente de herbáceas perennes, de tallos semi-postrados y estoloníferos; aparecen también algunas especies arbustivas en esta comunidad, como *D. viscosa*, que en ciertos sitios son fisonómicamente dominantes, así como elementos

achaparrados de especies propiamente arbóreas, como *Guettarda insularis* T.S. Brandege, y *Prunus serotina* Ehrh. La altura media de estas especies varía entre 1 m y 2.5 m. El helecho *Pteridium caudatum* (L.) Maxon es muy abundante y en ocasiones forma densos manchones, puede considerarse como una especie pionera o integrante de las primeras etapas sucesionales, dada su elevada demanda de radiación solar, alta producción de estructuras reproductivas (esporas), y requerimientos relativos bajos de calidad edáfica.

Si bien esta comunidad guarda cierta unidad fisonómica en el área considerada, su composición florística cambia dependiendo de las condiciones topográficas, altitudinales, sucesionales y de exposición. Algunas especies representativas son:

<i>Acalypha umbrosa</i> T.S. Brandege	<i>Galium mexicanum</i> Kunth in Humb.
<i>Bidens socorrensis</i> Moran & Levin	subsp. <i>mexicanum</i>
<i>Brickellia peninsularis</i> T.S. Brandege var.	<i>Hibiscus diversifolius</i> Jacq.
<i>amphithalassa</i> Robinson ex I.M. Johnst.	<i>Lepechinia hastata</i> (A. Gray) Epling var.
<i>Cardiospermum halicacabum</i> L.	<i>socorrensis</i> Moran
<i>Caesalpinia bonduc</i> (L.) Roxb.	<i>Phaseolus lunatus</i> L.
<i>Coreocarpus insularis</i> (T.S. Brandege) E.B. Smith	<i>Rubus</i> sp.
<i>Eupatorium pacificum</i> Robinson ex I.M. Johnst.	<i>Salvia pseudomisella</i> Moran & Levin
	<i>Spermacoce nesiotica</i> (Robinson) Levin
	<i>Triumfetta socorrensis</i> T.S. Brandege
	<i>Waltheria indica</i> L.

En el mapa de la Fig. 1 se señala el matorral de *Psidium (socorrense)*. Éste se encuentra ya casi desaparecido por la erosión de su suelo, los autores consideramos que de manera natural se encontraba integrado en el matorral mixto (ver más adelante el apartado de Áreas Erosionadas).

5. Bosque Tropical Perennifolio

Bajo esta denominación se incluyen “selva de higueras,” con o sin guayabillo, y “selva de zapotillo-guayabillo” de acuerdo a la clasificación empleada por Miranda (Adem et al. 1960). Levin y Moran (1989) usan la denominación “forest.” En su conjunto los bosques ocupan una superficie aproximada de 51.3 km² (24.4%, ver Fig. 1). Las formas biológicas características de los bosques son árboles, con densidades relativamente bajas pero con un amplio dosel. La dominancia relativa de las especies parece variar en función de los niveles altitudinales, de acuerdo con los datos florísticos y estructurales (no presentados en este trabajo), la comunidad boscosa se puede subdividir en tres agrupaciones.

Bosquetes de *Ficus*

Entre los 250 y 500 m de altitud, se localizan bosquetes de *Ficus cotinifolia* Kunth in Humb. (amate, higuera o higuera), ocupando mesetas con pendientes leves y suelos aparentemente profundos.

Estos bosquetes se distribuyen discontinuamente formando manchones

sobre los diferentes flancos de la isla, ocupando mayor superficie en el sudeste, donde existen evidencias de un fuerte proceso de deterioro debido a la continua pérdida de suelo como efecto del sobrepastoreo del borrego.

Ficus cotinifolia extiende su dosel hasta en algunos centenares de m² de cobertura, su densidad es difícil de calcular, ya que es difícil distinguir a cada individuo por la forma de propagación vegetativa de la especie. Las otras especies leñosas presentes en este tipo de bosques, tienen escasa aportación a la dominancia. Tanto *Bumelia socorrensis* como *Guettarda insularis* forman, junto con *F. cotinifolia*, el estrato arbóreo superior con una altura de 5 a 7 m. El estrato arbóreo bajo (de 2 a 3 m de altura) está compuesto principalmente por individuos abundantes de *Psidium* aff. *sartorianum* (O. Berg.) Niedenzu.

El estrato herbáceo de estos bosques es poco conspicuo, quizá debido a la densa cubierta vegetal de los árboles, la baja incidencia de luz, y al sobrepastoreo por borregos. Sólo en los márgenes de cada bosquete se ubican algunas especies herbáceas y arbustivas, entre las que se encuentran *Nicotiana stocktonii* T.S. Brandege, *Opuntia* sp., y *Argemone ochroleuca* Sweet, mismas que parecen ser favorecidas por la actividad selectiva del borrego.

Bosque de *Bumelia-Psidium*

Este tipo de agrupación se distribuye en el gradiente altitudinal de 500 a 700 m, sobre laderas y cañadas del volcán Everman, en sitios de pendientes moderadas. Esta agrupación presenta mayor número de especies arbóreas que los bosquetes de *F. cotinifolia*, entre las principales se encuentran:

Bumelia socorrensis T.S. Brandege
Guettarda insularis T.S. Brandege
Ilex socorroensis T.S. Brandege

Psidium socorrense I.M. Johnston
Psidium aff. *sartorianum* (O. Berg.)
 Niedenzu

Bajo el dosel arbóreo se encuentran algunas especies trepadoras y arbustos decumbentes como: *Chiococca alba* (L.) A. Hitchc., *Vernonia littoralis* T.S. Brandege, *Forestiera rhamnifolia* Griseb., y *Zanthoxylum insulare* Rose, así como algunas epífitas como: *Cattleya aurantiaca* (Bateman) P. N. Don, *Peperomia tetraphylla* (G. Forster) Hook & Arn., *P. socorronis* Trel. in I.M. Johnston, *Polypodium polypodioides* (L.) Watt var. *aciculare* Weath.

Bosque de *Oreopanax-Ilex*

Este tipo de agrupación se localiza en la parte noroeste de la isla, en altitudes superiores a los 700 m, es la más densa de todas y presenta el mayor número de especies. *Oreopanax xalapense* (Kunth) Decne. & Planchon e *Ilex socorroensis* parecen ser las especies con mayor dominancia; como especies acompañantes se encuentran *Guettarda insularis*, *Bumelia socorrensis* y *Meliosma nesites* I.M. Johnston, las cuales pueden rebasar los 11 m de altura. La mayoría de los individuos presentan una altura máxima entre 5 y 8 m.

Los componentes exhiben coberturas con ramificación densa y abundante;

posiblemente ocupan la isolínea que delimita el régimen térmico relativamente estable, tropical, de otro con mayores fluctuaciones diurnas y/o estacionales, ya que súbitamente desaparecen los escasos individuos de *Ficus* y *Psidium*, mientras que *M. nesites*, *O. xalapense* y *Prunus serotina* aparecen con dominancia. Estas últimas especies son propias de algunos bosques mesófilos de montaña en la superficie continental del país.

La franja altitudinal de 700 a 900 m, parece ser la que mayor humedad recibe gracias a la constante neblina, que al ser condensada sobre los árboles, facilita que éstos se cubran densamente con líquenes. En el sotobosque aparecen varios helechos como:

Adiantopsis radiata (L.) Fée
Asplenium sessilifolium Desvaux
Asplenium formosum Willd.

Polypodium alfredii Rosenstock
Polystichum muricatum (L.) Fée

6. Pradera

Corresponde a la “pradera” de Miranda (Adem et al. 1960) y a la “prairie” de Levin y Moran (1989). El bosque desaparece repentinamente en niveles altitudinales situados entre los 850 y 950 m de altitud, para dar lugar a esta comunidad que se desarrolla sobre suelos pedregosos y rocosos, con pronunciada pendiente. La pradera ocupa la parte central de la isla, sobre el cono del volcán Evermann, con una superficie de 1.3 km² (0.7%). Además de la carencia de suelo, otros factores limitantes para el crecimiento de especies leñosas son el viento fuerte y las temperaturas relativamente bajas que allí inciden. Son especies características:

Aegopogon solisii Levin
Aristida vaginata A. Hitchc.
Castilleja socorrensis Moran
Centaureum capense Broome
C. wigginsii Broome
Cestrum pacificum T.S. Brandegees
Cleome viscosa L.
Daucus montanus Humb. & Bonpl.
Eupatorium pacificum
Gnaphalium attenuatum DC.
Gnaphalium sphacilatum Kunth in Humb.

Heterotoma cordifolia (Hook. & Arn.)
 McVaugh
Hypericum eastwoodianum I.M. Johnston
Linaria canadensis (L.) Dum.-Cours. var.
texana (Scheele) Pennell
Setaria geniculata (Lam.) P. Beauv.
Spermacoce nesiotica (Robinson) Levin
Sporobolus purpurascens (Sw.) W. Ham.
Triodanis perfoliata (L.) Nieuwl. var. *biflora*
 (Ruíz Lopez et Pavón) Bradley

7. Superficies Erosionadas

La presencia del borrego doméstico en la isla ha ocasionado una grave y acelerada erosión, especialmente en la vertiente sur-centro. Este óvulo fue introducido hacia 1869 (Gentry 1949), su población ha prosperado principalmente en la región sur, y actualmente se calcula una población de 2 mil animales en la mitad sur de la isla (Cárdenas et al. 1994).

El efecto de sobrepastoreo y pérdida de suelo, se ha acentuado en los últimos 30 años, ya que Miranda (Adem et al. 1960) en 1958, advierte el

efecto del borrego sobre la vegetación, particularmente en las áreas correspondientes a la comunidad que denominó como “matorral de guayabillo” (*Psidium socorrense*). Esta especie endémica ha disminuido considerablemente sus poblaciones naturales, ya que ocupó las escasas áreas planas del sur, este y oeste de la isla, las mismas que actualmente son deterioradas por las manadas de borrego, la acción eólica y la erosión pluvial. En la actualidad cerca de 38.5 km² (18.3%) se encuentran severamente afectados y solamente quedan dos superficies reducidas del matorral de guayabillo, que cubren alrededor de 4.5 km² (Fig. 1).

Las superficies erosionadas mantienen una flora muy pobre en cuanto a individuos y número de especies, las fases más graves se localizan sobre pendientes fuertes, en donde las cárcavas proporcionan un panorama impresionante en el paisaje.

Sobre algunas mesetas erosionadas, ubicadas entre los 260 y 400 m de altitud, se desarrolla una comunidad secundaria, originada a partir de la desaparición de superficies posiblemente correspondientes a bosquetes de *Ficus cotinifolia*, *Psidium* sp., y *Guettarda insularis* y del matorral decíduo. Sobre estas mesetas se desarrollan algunos arbustos y especies anuales, éstas últimas aparecen después de la temporada de lluvias. La especie con mayor densidad de individuos es *Mitracarpus hirtus* (L.) DC., que puede considerarse la invasora más agresiva de la isla, pues a pesar de su introducción relativamente reciente ingreso (Levin y Moran 1989) se encuentra presente en prácticamente todas las comunidades. Otras especies presentes en estos sitios son:

<i>Aristida adscensionis</i> L.	<i>Corchorus aestuans</i> L.
<i>Aristida vaginata</i> A. Hitch.	<i>Cynodon dactylon</i> (L.) Pers.
<i>Boerhavia coccinea</i> Miller	<i>Dactyloctenium aegyptium</i> (L.) Willd.
<i>Cenchrus echinatus</i> L.	<i>Desmodium procumbens</i> (Miller) A. Hitchc.
<i>Cenchrus myosuroides</i> Kunth in Humb.	<i>Eragrostis pectinacea</i> (Michaux) Nees
<i>Chamaesyce anthonyi</i> (T.S. Brandegees)	<i>Malvastrum coromandelianum</i> (L.) Garcke
Levin	<i>Paspalum longum</i> Chase
<i>Chamaesyce hirta</i> (L.) Millsp. var. <i>hirta</i>	<i>Rhynchelytrum repens</i> (Willd.) Hubb.
<i>Chamaesyce byssopifolia</i> (L.) Small	<i>Verbena sphaerocarpa</i> Perry

En las cárcavas profundas que surcan pendientes moderadas y pronunciadas, originadas por aguas broncas provenientes de mayores altitudes, se ponen al descubierto suelos rojos, volcánicos, arcillosos. En la mayor parte de estas zonas no existe vegetación; sin embargo, en algunos sitios logran instalarse unas pocas especies en estas condiciones, correspondiendo a malezas de introducción reciente a la isla como:

<i>Argemone ochroleuca</i> Sweet. var. <i>ochroleuca</i>	<i>Portulaca oleracea</i> L.
<i>Cyperus rotundus</i> L.	<i>Salvia riparia</i> H.B.K.
<i>Glinus radiatus</i> (Ruiz et Pavón) Rohrb.	<i>Sida rhombifolia</i> L.
<i>Mollugo verticillata</i> L.	

c) Especies de amplia distribución

Es posible encontrar ciertas especies en varios tipos de vegetación, por lo que aparentan ser taxa de amplia tolerancia ambiental. A excepción de *Mitracarpus hirtus*, ninguna de éstas llega a dominar en una superficie dada y todas son especies herbáceas. A continuación se listan algunas de estas especies, indicándose si son nativas o naturalizadas (1), o bien si son de introducción reciente (2), ésto es, si han aparecido en las últimas colectas.

<i>Asplenium formosum</i> Willd. Willd. (1)	<i>Eragrostis ciliaris</i> (L.) R. Br. (2)
<i>Bulbostylis nesiotica</i> (I.M. Johnst.) Fern. (1)	<i>Mitracarpus hirtus</i> (L.) DC.(2)
<i>Cyperus duripes</i> I.M. Johnst.(1)	<i>Schizachyrium sanguineum</i> (Retz) Alston
<i>Chamaesyce anthonyi</i> (T.S. Brandegees) Levin (1)	var. <i>sanguineum</i> (1)
<i>Cheilanthes peninsularis</i> Maxon var. <i>insularis</i> Weath (1)	<i>Sorghastrum nutans</i> (L.) Nash (1)
<i>Elytraria imbricata</i> (Vahl.) Pers. (1)	<i>Verbena sphaerocarpa</i> Perry (1)
	<i>Waltheria indica</i> L. (1)

d) Distribución de la flora por comunidad

El cuadro 3 muestra la riqueza florística de cada una de las comunidades vegetales consideradas (el matorral de *Psidium* señalado en el mapa está contenido aquí en el matorral mixto). Si bien es posible señalar que el matorral mixto, el bosque y las áreas erosionadas presentan una relativa “riqueza” de especies, la abundancia de cada taxon podría mostrar otro panorama. De esta manera, las áreas erosionadas las ocupan especies herbáceas (anuales y perennes) de abundancia local y temporal.

Otro aspecto que llama la atención es que prácticamente todas las especies de introducción reciente (42/46) se ubican en las áreas alteradas (áreas erosionadas + pastizales).

DISCUSION

En el cuadro 4 se hace una comparación de las diferentes clasificaciones de la vegetación de la Isla Socorro. En este cuadro se advierte que la clasificación propuesta por Levin y Moran (1989) es más general que las otras dos, no hace diferencia en los subtipos de matorrales y bosques. La clasificación propuesta por Miranda (Adem et al. 1960) comprende siete tipos de vegetación, en ella describe el matorral de guayabillo entre los 250 y 400 m, sobre suelos rojos, también advierte la presencia del borrego sobre esta comunidad vegetal. En la actualidad este matorral se encuentra fuertemente afectado ya que ocupaba las áreas que hoy presentan la erosión más severa, quedando solamente algunos manchones de esta comunidad.

En la clasificación de Miranda (Adem et al. 1960) no se contempla el pastizal como un tipo de vegetación, en su trabajo, menciona solamente el establecimiento de especies herbáceas en los claros del matorral de *Croton*, pero cabe señalar que en el momento de esta observación el impacto de la

CUADRO 3. Riqueza específica por comunidad vegetal en isla socorro, Rev. (flora nativa + adventicia).

Agrupación	taxa
Matorral mixto (incluye matorral de <i>Psidium</i>)	53
Matorral de <i>Croton</i>	39
Bosque tropical perenifolio (incluye bosquetes de <i>Ficus</i>)	50
Pastizal	49
Agrupaciones costeras	30
Pradera	35
Superficies erosionadas	48

CUADRO 4. Sinopsis de las clasificaciones de la vegetación empleadas para Isla Socorro, Rev.

Miranda (1960)	Levin y Moran (1989)	Esta propuesta
Agrupaciones de haló fitos costeros (en parte)	Shore	Agrupaciones costeras
Matorral de <i>Croton</i>	Scrub	Matorral de <i>Croton</i>
Matorral de Guayabillo	—	Matorral mixto (Matorral de <i>Psidium</i> casi desaparecido)
Selva de amates con o sin guayavillo	Forest	Bosque tropical perennifolio (Bosque de <i>Ficus</i>)
Selva zapotillo-guayabillo	Forest	Bosque tropical perennifolio (Bosque de <i>Bumelia-Psidium</i> y Bosque de <i>Oreopanax-Ilex</i>)
Matorral de <i>Dodonea</i>	Scrub	Matorral mixto
Pradera	Summit	Pradera
Agrupaciones de haló fitos costeros (en parte)	Grassland	Pastizal (agrupación secundaria)
—	—	Superficies erosionadas

base naval (Cabo Regla) debió ser apenas incipiente, en la actualidad este tipo de vegetación se ha desarrollado, principalmente, como producto de las perturbaciones antropogénicas, que convierten partes del matorral de *Croton* en pastizales. En la clasificación propuesta en este trabajo, se propone el término “matorral mixto” obedeciendo a la heterogeneidad en la composición florística de esta unidad. Un ajuste a la clasificación de Miranda (Adem et al. 1960) es la subdivisión del Bosque Tropical Perenifolio, donde aquel autor propuso un tipo caracterizado por *Meliosma* y *Oreopanax*, mientras que en el presente trabajo se consideró como una subunidad, dado que estas especies no se apartan de la fisonomía propiamente boscosa.

La nomenclatura propuesta en este trabajo, no se corresponde con los nombres empleados para designar a los grandes tipos de vegetación en México (Miranda y Hernández X 1963; Rzedowski y McVaugh 1966; Rzedowski 1978), ya que son escalas geográficas dispares y en este caso se considera una descripción de la vegetación en escala local.

Los resultados de este trabajo, así como lo señalado en estudios anteriores muestran que proporcionalmente a la superficie de la Isla Socorro (210 km²), existe cierta diversidad de tipos de vegetación que corresponden a diferentes factores ambientales. El gradiente altitudinal y la exposición de la isla influyen en cambios climáticos que permiten el establecimiento de diferentes comunidades vegetales a lo largo del gradiente altitudinal. Son también notorios los variados tipos de suelos presentes en esta pequeña isla (Maya et al. 1995) como producto de la intensa actividad volcánica de la región. Esta combinación de factores permiten una relativa diversidad de ambientes y el establecimiento de diferentes tipos de vegetación.

La relativa diversidad de comunidades vegetales en la isla contrasta con lo planteado por Levin y Moran (1989) en torno a la flora; de acuerdo con estos autores el endemismo de la flora puede catalogarse como “moderado” (26.5% de la flora nativa, comparado con las islas Hawaianas que presentan niveles superiores al 90%), pues consideran que una de las principales causas que lo explican son las reducidas dimensiones de la isla y los escasos microambientes particulares que promueven la radiación adaptativa de los taxa existentes. Sin embargo, la distinción de varias comunidades vegetales es un reflejo de ambientes diversos, en cada uno de los cuales se presentan ciertos grados de presión selectiva. Probablemente, otros factores que mencionan Levin y Moran (1989), como el relativo pequeño tamaño del archipiélago Revillagigedo y la cercanía de isla Socorro al macizo continental, sean aspectos de mayor influencia sobre el moderado número de especies endémicas de la isla. De igual forma este fenómeno puede además encontrar una respuesta en el origen de la misma isla, posiblemente de unos pocos millones de años (Bohrson 1994). No deben descartarse, tampoco, la extinción masiva de la biota por erupciones volcánicas durante el pasado, tal y como sucedió en la década de los años 50^s en la cercana isla San Benedicto, tras lo cual, el proceso de sucesión primaria ha tomado reiteradamente su lugar.

Cabría señalar que la alta proporción de especies herbáceas sobre la isla (más de la mitad de las especies, ver cuadro 2), y particularmente de gramíneas y compuestas, formas de crecimiento y grupos taxonómicos que exhiben una alta capacidad de dispersión, puede interpretarse como un hecho que supone una colonización relativamente reciente. Tal capacidad obedece probablemente a sus estrategias reproductivas y síndromes de diseminación,

entre los que cabe mencionar el bajo concurso de polinizadores y su predisposición a la autogamia y la agamospermia, la baja proporción biomasa total/número de semillas, la tendencia a la anemocoria, la aparente alta viabilidad de semillas y la elevada tasa de crecimiento en el estadio de plántula (Carlquist 1974 y Grant 1971). Todas estas características representan condiciones para alcanzar y prosperar en comunidades insulares.

CONCLUSIONES

El conjunto de condiciones ambientales propias de la posición geográfica y la acción antropogénica, han favorecido el desarrollo de diferentes tipos de vegetación en la isla. Algunas comunidades, como los bosques, parecen establecerse en lugares condicionados por las variaciones ambientales impuestas por el gradiente altitudinal; en tanto que otras, como el matorral de *Croton masonii* que se establece primordialmente sobre las capas basálticas, deben su presencia al tipo de sustrato. Los pastizales actuales deben considerarse comunidades secundarias, generadas a partir de la acción humana sobre áreas del matorral de *C. masonii* con cierta acumulación de suelo.

Los bosques sustentan el mayor número de las especies del biota de vertebrados terrestres presentes en la isla, particularmente de aves (Brattstrom 1990, Rodríguez-Estrella et al. 1995), que ejercen una activa función ecológica. El bosque ubicado en la parte norte de la isla (bosque de *Oreopanax-Ilex*) es el de mayor diversidad florística y posiblemente la presencia de esta comunidad en esta parte del área se debe a su exposición a las corrientes húmedas, a la neblina, y consecuentemente a una menor incidencia de radiación.

Analizando el conjunto de comunidades boscosas, destaca la presencia continua de *Bumelia socorrensis* y *Guettarda insularis*, en tanto que *Psidium* aff. *sartorianum* sólo se registra en el sector sur; también, *Oreopanax xalapense* y *Meliosma nesites* presentan una distribución restringida a las mayores elevaciones.

Del estudio actual de la vegetación de isla Socorro destaca la severa erosión a la que se encuentra sujeta, así como a los drásticos cambios sufridos durante los últimos treinta años, como producto del sobrepastoreo de las poblaciones de borrego. Urgen medidas de control de la erosión en el área señalada en la Fig. 1 de este trabajo. Es difícil pensar en la instalación de infraestructura que contenga la avenida de los arroyos y torrenteras, como presas de gaviones y otras, debido a los elevados costos, mano de obra y problemas logísticos que implicarían. Los autores consideran que el repoblamiento con especies nativas, como *Opuntia* sp., *Dodonaea viscosa* e incluso *Pteridium caudatum*, pueden coadyuvar a la atenuación de la erosión,

ya que presentan características propias para desarrollarse bajo esas condiciones. Son altamente recomendables investigaciones que atiendan este problema.

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CATALPA (*CATALPA BIGNONIOIDES*, BIGNONIACEAE) AND BOIS D'ARC (*MACLURA POMIFERA*, MORACEAE) IN EARLY TEXAS RECORDS

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ABSTRACT

Field notes of pre-1860 Texas surveys in the Texas General Land Office were read and the included data on witness trees collected. This data were analyzed for evidence concerning the indigenous range of three trees: *Catalpa speciosa* Warder, *Catalpa bignonioides* Walt., and *Maclura pomifera* (Raf.) Schneid. Catalpas were named as witness trees before 1860 in only two east Texas counties, Jasper and Newton. Their presence in the surveyors' reports from only these two contiguous counties, with their absence from the thousands of reports from the rest of the state, is advanced as evidence that these two counties make up most, if not all of any Catalpa's indigenous range in Texas. The location of these two counties being at the southeast Texas border seems to indicate that only *C. bignonioides* (the Southern Catalpa) should be considered indigenous in this state. Bois d' arcs appear as witness trees before 1860 in only 12 northeast Texas counties. This is presented as evidence that the native range of *Maclura pomifera* in Texas was probably limited to those 12 counties.

RESUMEN

Se leyeron las notas de campo de los informes sobre Texas, anteriores a 1860, de la Texas General Land Office y se recogieron los datos existentes acerca de los árboles testigo. Estos datos fueron analizados para buscar evidencias acerca del área autóctona de tres árboles: *Catalpa speciosa* Warder, *Catalpa bignonioides* Walt., y *Maclura pomifera* (Raf.) Schneid. Antes de 1860 las catalpas fueron designadas como árboles testigo en sólo dos condados del este de Texas, Jasper y Newton. Su presencia en los informes de los topógrafos en sólo estos dos condados contiguos, junto con su ausencia de miles de informes del resto del estado, se toma como evidencia de que estos dos condados forman la mayor parte, si no el total del área autóctona de Catalpa en Texas. La localización de estos dos condados en la frontera sudeste de Texas parece indicar que sólo *C. bignonioides* (la catalpa del sur) deba ser considerada autóctona en este estado. Antes de 1860 *Maclura pomifera* aparece, como árbol testigo, en sólo 12 condados del nordeste de Texas. Esto se presenta como evidencia de que el área nativa de *Maclura pomifera* en Texas estaba limitada probablemente a estos 12 condados.

More than 50 years ago it came to the attention of some who were studying the history of plant communities that there was a wealth of information for them in accounts of witness trees included in the field notes of

early surveyors. Those surveyors did not have the luxury of leaving permanent markers indicating the points on their lines or of having sophisticated instruments with which to relocate the points, so it was important for them to leave directions enabling those coming after them to relocate the points by using the natural surroundings. To help make that possible it was the early surveyor's responsibility to follow certain instructions of the surveyors-general. Those procedures were outlined by Dodds et al. (1943).

Those directions mandated that the surveyors, after establishing points, were to locate the trees nearest to the points. Those trees were called "witness trees." And it was the surveyor's duty to record in his field notes the direction by compass reading and the measured distance from each point to at least one witness tree, as well as to note the species of that tree and its trunk diameter. Although almost none of those witness trees still survive, the original records of where and what species literally millions of them were are carefully preserved in official files of the governmental land offices of the U.S.

Lutz (1930) was among the first to make use of this material to help determine the original vegetation of an area. Other early studies based to a large extent on the witness tree records were those of McIntosh (1962), Oosting (1942), and Stearns (1949).

There soon was so much reliance on these witness tree records that it became necessary to deal with any possible bias or negligence on the part of the surveyors. Several ways in which they might have skewed their tree records were pointed out.

It is possible that they might have bypassed small trees and chosen only large specimens to mark and record. However, it does not seem that this happened in any significant amount, since I find many witness trees recorded as only 6 inches in diameter; the smallest one in early Texas records was a sapling only 4 inches in diameter. In other places even smaller trees were sometimes used. The 1832 survey of Sumter County, Alabama, includes witness trees down to 2 inches in diameter (Jones & Patton 1966), and it has been stated that, "in exceptional cases, 2 and 3 inch stems were blazed" (Bourdo 1956).

It could be surmised that surveyors might discriminate against short-lived and cull trees, but, since willows, birches, and understory witness trees appear regularly in environments appropriate for them, this does not seem a significant factor. Bourdo (1956) pointed out that the trees selected may be expected to present a complete qualitative list of what was present because "there is a tendency to use an uncommon species . . . because relocation of the corner will be easier."

Some have thought that surveyors, by just not bothering to record trees, might have left an incomplete record of them, but the urge to minimize

labor seems to have kept this from being a significant factor. In most cases any surveyor not finding a tree within reasonable distance from any point was expected to erect a cairn of stones on that point. The time and work involved in doing this would not have been relished, and the fact that I find some witness trees described as being many yards away from their points shows that the surveyors chose to measure quite long distances to trees rather than to laboriously gather stones and erect monuments. And the paucity of cairn records in any but what are known to have been very open deserts or grasslands emphasizes that if there was any tree in the vicinity of a point it can be presumed that it was recorded.

There was sometimes malpractice and even fraud in surveying, resulting in points and lines being misplaced. However, this does not need to concern us, because even though such incorrectly located points introduced errors into land plats, they were still arrived at without regard for existing trees. Bourdo (1956) concluded that "errors of this sort do not necessarily affect the usefulness of the field notes."

Studies based on Texas witness trees came late and have been few, but some workers, such as Harcombe and Marks (1977) and Schafale and Harcombe (1983), used them in reconstructing some of the original forest communities of southeastern Texas.

All these studies have dealt with plant communities on a more or less local and quantitative level. It occurred to me that the witness tree evidence could show a different kind of qualitative reality when viewed from a broader perspective. I therefore embarked upon an attempt to get a general view of the whole of early Texas in its original state as shown by the witness trees the surveyors said were present before significant settler interference with them. Because of the knowledge of on-going processes that caused significant changes in the natural ecology after 1860, I chose 1860 as my cut-off date and used only surveys made up to that date to establish the original scene.

In this study I was able to go through all field notes of the pre-1860 surveys in the general file in the Records Division of the Texas General Land Office, Austin. I compiled data on 153,030 witness trees as described in 22,879 early Texas land surveys. Each survey was located by the Land Office down to the county in which it is presently included. The surveys are on file as official land office records and are available for study in the Texas General Land Office. From these I have therefore been able to make lists of the trees officially declared to have been part of the original vegetation of each present county, and also to make range maps showing the counties in which each species was found growing before 1860 and in which each species can therefore be presumed indigenous.

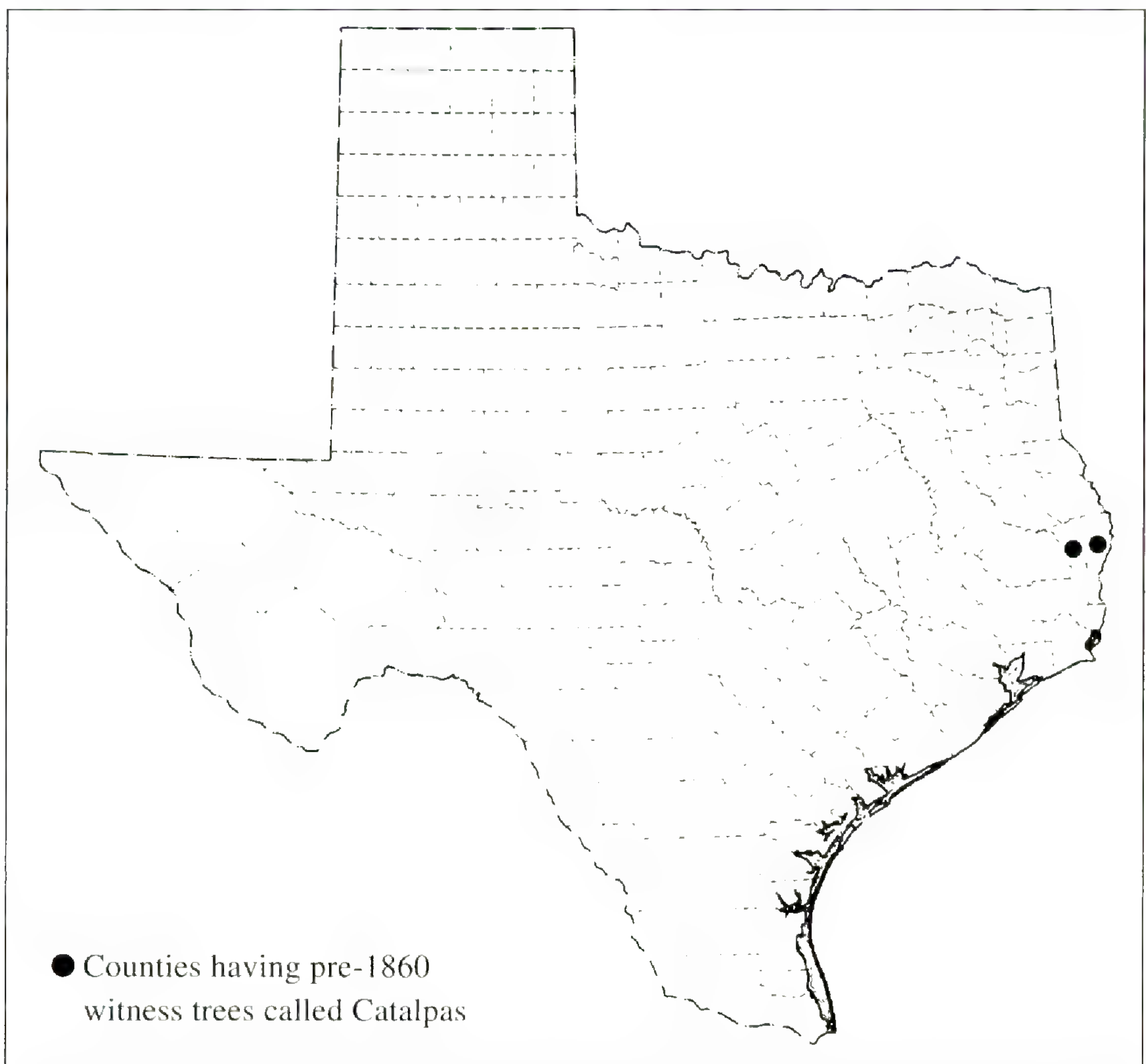


FIG. 1. Texas counties having pre-1860 witness trees called "catalpas."

WITNESS TREE DATA APPLIED TO THE ENIGMA OF TEXAS CATALPAS

Catalpa is the American Indian name for some trees found in scattered locations almost throughout the eastern half of the U.S. That such a word has entered our language as the accepted common name for some trees and that the word has even become the name for the genus indicates that these are indigenous American trees. It is also generally agreed that there are two species of this genus in the U.S. One, *Catalpa speciosa* Warder, the northern catalpa, is indigenous in the central Mississippi River basin, with general agreement that it grew native from at least Indiana and Illinois southwest into Missouri and Arkansas. The other, *Catalpa bignonioides* Walt., the southern catalpa, is thought to have been native from Florida west into at least Mississippi and, according to some, into Louisiana.

But today we find catalpas in scattered locations almost throughout Texas, sometimes planted, sometimes growing wild. So what about the catalpas in Texas today? Are they Texas natives or not? If native, where in Texas did

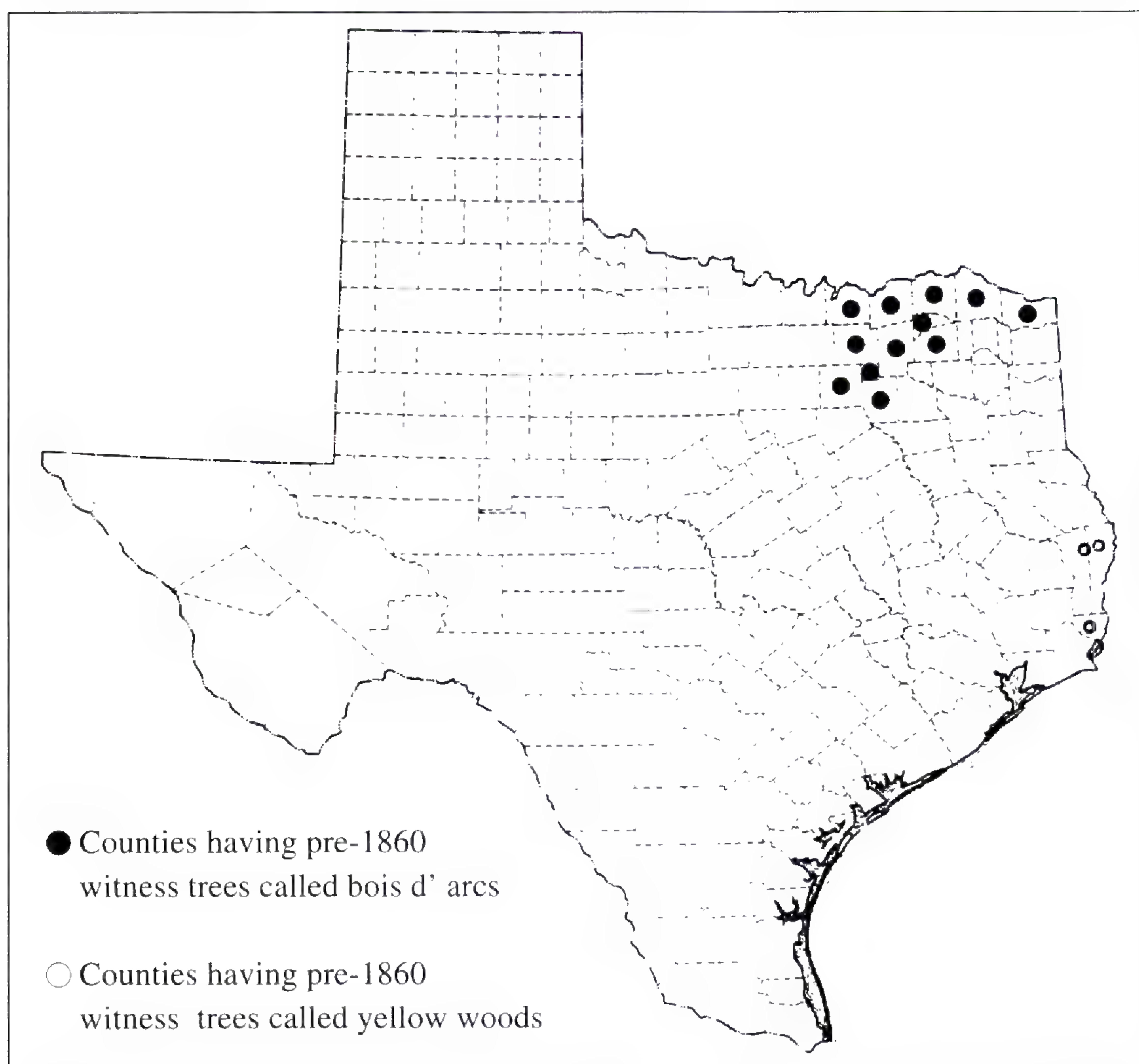


FIG. 2. Texas counties having pre-1860 witness trees called "bois d'arcs" and "yellow woods."

they originally grow? Botanists dealing specifically with Texas leave us with rather uncertain and sometimes even contradictory answers to these questions.

Concerning the northern catalpa, Sargent (1905), writing early, stated flatly that this tree was not native anywhere in southern Arkansas, western Louisiana, or eastern Texas. Harrar and Harrar (1946) gave its range as from "Illinois and Indiana south to Arkansas," thus leaving out Texas all together. A guide to the trees of Texas published by the Texas Forestry Association (1928) says *C. speciosa* "is found naturalized in east Texas," so denying it a Texas origin. Vines (1960) and Correll and Johnston (1970) were noncommittal, dealing only with the tree's present distribution. Simpson (1988), by not even listing it in his guide to Texas trees, makes it clear that he does not consider this a Texas tree. But Shinnars (1958), in his study of northern Texas plants, says the tree is "rare as a native tree in pine belt [of Texas]," although he attributes the statement to Smith (1970).

There is equal disagreement about *C. bignonioides* in Texas. Small (1903) early stated that the tree is native in southeastern Texas. Reeves and Bain (1946) also considered it to be a Texas tree. Vines (1960), however, said it is "thought to be native from Florida and Georgia, westward into Louisiana. Doubtful whether native in Texas." Correll and Johnston (1970) did not commit themselves on the point. Harrar and Harrar (1946) made the definite statement that the tree ranges west only as far as Mississippi, and neither the Texas Forestry Association (1928) nor Simpson (1988) even mentioned this species, these latter three at least implying that the tree is not indigenous to Texas.

So we have the enigma of Texas catalpas. They may both, the northern and the southern, be here today. But is either one indigenous here? Is there any way to determine that from any actual evidence?

The accompanying map shows the present counties of Texas in which catalpas were found and recorded as witness trees prior to 1860. They appear only in surveys of Jasper and Newton counties of that early era. This is significant in several ways.

First, the fact that there was not one catalpa among all of the thousands of trees used as witness trees in all of northeastern Texas, which was apparently the first region of the state to be widely surveyed, makes it highly unlikely that there were any indigenous catalpas in that region of Texas.

Second, catalpas recorded as growing in two counties just within the southeastern corner of Texas at such an early time provide evidence hard to deny that some catalpa is indigenous to that limited part of the state. This is especially true because some of those catalpas had to have been already mature and grand in size when the pioneers first entered Texas. So early as 1838, in listing the forest trees found in Texas at that time, von Wrede (1970) described them in the following words: "Next would be the catalpa tree which is forty to fifty feet high, with a trunk up to three feet in diameter and foot-long leaves which are eight to ten inches wide. Its flower, a pyramid-shaped cluster similar to the horse chestnut, is a magnificent sight."

Third, the absence of any early-day catalpas from all of northeastern Texas makes it highly unlikely that the northern catalpa was native to the state. If those found down in Jasper and Newton counties were *C. speciosa* they would have been a relict population isolated by several hundred miles and a very different environment from the nearest definitely known native stands of that species.

And fourth, those catalpas found growing just within the southeastern border of Texas were separated by no large distance or major environmental factors from the known range of *C. bignonioides*. It would seem to follow, then, that these catalpas must have been the southern catalpa, extending that species' known range just into Texas.

I submit that this is clear and adequate new evidence allowing us to put *C. bignonioides* into the list of indigenous Texas trees but also indicating that we should delete *C. speciosa* from that list.

THE BOIS D'ARC IN EARLY TEXAS RECORDS

The bois d'arc or Osage-orange, *Maclura pomifera* (Raf.) Schneid., has been called "perhaps one of the classic examples of an endemic species in North America" (Smith and Perino 1981). Endemic it certainly is, and as Texan as any, but that does not mean there has been consensus about the tree's natural range in Texas.

Some authorities, for instance Correll and Johnston (1970), have merely made general comments about the tree's being found growing in at least Oklahoma, Texas, and Arkansas but avoid being more specific. Beyond this, statements of its natural range in Texas are widely divergent. Collingwood (1939) claimed the tree was native from beyond the Red and Sabine rivers southwest to at least the Rio Grande and beyond the lower Pecos River. Betts (1953) claimed it was native over all of eastern Texas but the coastal plain and all of central Texas to beyond San Antonio. Burton (1963) drew its natural range as a narrower belt from the northeastern corner of the state down to an arc from about San Antonio on the west to the coastal plain near Wharton. Such ambiguity concerning an endemic species is remarkable, and there must be a reason for it.

The reason for this uncertainty concerning the original range of this tree is that even before the time of first botanizing in this region bois d'arc had already been introduced into new areas far outside its original range. How very early this process was going on is attested to by the remarkable statement of Custis (1984). In his catalog of plants he found in 1806 on the Red River he wrote, "Bois d'arc, of this tree you have already had a description.—it is probably a new Genus . . . it is said first to make its appearance about the 2nd Little river and is very abundant on a creek called Bois d'arc. The tree which I saw was one growing within a mile of Nachitoches [Louisiana] & was probably transplanted.—This is about 30 ft. high; its trunk 7 to 8 ft. in circumference & about 6 to 7 ft. to where it begins to ramify.—its general aspect is that of an apple tree.—its fruit is about the size of the large sour Oranges and of a greenish yellow."

Any tree having attained by 1806 the size described by Custis (1984) must have been transplanted long before, perhaps when there was no one present at that site to do the job except Indians. This may mean ascribing much more in the way of horticulture to the Indians than we would have suspected, but Custis' observation may require it. His editor notes that, "Scattered trees found farther east, in the vicinity of the Caddo settlements, quite possibly were transplanted by the Indians." Simpson (1988) recently

noted that "Bois d'Arc shows up in many places in the Trans-Pecos—always at Indian campgrounds or caves . . . Today, great thickets of Bois d'Arc are found in these areas, seeded from the horse apples carried by these tribes."

The tree was also carried about by explorers and settlers. In 1804, Lewis (1962) wrote in a letter to Thomas Jefferson that he had sent him cuttings of this plant. Lewis stated that he had obtained the cuttings in St. Louis "from the Garden of Mr. Pierre Choteau . . . [who] informed me, that he obtained the young plant at the great Osage Village from an Indian of that nation, who said he procured them about three hundred miles west of the place." A huge individual of the species still stands on the grounds of the American Horticultural Association, within sight of the Potomac River. These grounds were once George Washington's River Farm, and since it is known that Jefferson gave Washington other trees, this individual may be either one of Lewis's cuttings or a descendant of them. There is also a single equally huge, old bois d'arc in the front yard of the Oatlands Plantation near Leesburg, Virginia. Since Jefferson is known to have visited this home as well, this may be another legacy of Lewis, through the agency of Jefferson. This chain of events emphasizes the remarkably early introduction of this species across the land. The tree proved so useful for living fences that John A. Wright, editor of the *Prairie Farmer*, and others were promoting it actively from the 1850s on.

Such widespread introductions of the tree have erased for all time any possibility of field work rediscovering the limits of the species' natural range. All we have now is some indication of where each author found it growing in his time. So how, at this late date, can we ever arrive at the true original range of this important endemic tree? I think there is a simple answer, but one involving much tedious research. It is simply to check explorers' written accounts and field notes from their surveying projects for their testimony concerning where they found these trees before the settlers came in and broadcast them. I have carried out such a lengthy records search for the state of Texas.

To this end I have read all of the surviving material written by people who were in Texas before 1860 that I have been able to locate. This includes eyewitness accounts of many aspects of the region in books, letters, itineraries, reports official and unofficial of exploring and military expeditions, diaries, etc., written by 290 explorers, soldiers, adventurers, settlers, and other pioneers who, up to 1860, experienced and observed the Texas wilderness and took the trouble to write about it. I have not used any reminiscences written at a distance from the observations and so subject to possible errors of memory or the prideful embellishments of old-timers. In

these accounts there are thousands of reports of different trees found growing in those early days in Texas. I have not found any distinct tree species generally recognized as native to Texas that is not reported by at least some of these explorers. And the bois d'arc is there.

Among all those tree descriptions I have found only 14 pre-1860, contemporarily written records of bois d'arcs growing in Texas. The small number of these early bois d'arc reports seems very significant in itself, when compared to the more than 600 separate written records of mesquites appearing in those pioneers' accounts. This alone would seem to promote a healthy skepticism about the hypothesis that the bois d'arc was native to any wide area of the state.

I have also tabulated the data on 153,030 witness trees located and named in early Texas surveys. Of all these thousands of Texas witness trees, only 123 were bois d'arcs. This hardly portrays the species as of any general significance in the original tree cover of the state. And the locations where those naturally growing bois d'arcs were observed further reduces them from state-wide importance.

Map 2 shows the present counties of Texas in which bois d'arcs were named as witness trees up to 1860. The testimony of the early surveyors is that the species was then growing wild in what have become 12 counties: Bowie, Collin, Dallas, Delta, Fannin, Grayson, Hopkins, Hunt, Kaufman, Lamar, Red River, and Rockwall. Because in each of these counties some of these trees were stated to have been large, mature individuals, they must have been indigenous. And although it is impossible to prove a negative, the fact that, in more than 150,000 pre-1860 witness trees from all of the rest of Texas, there appears not one bois d'arc makes for a very strong presumption that this 12-county area was the total original range of this species in the state. This presumption is strengthened by the 14 explorers' accounts of the tree all in the same 12 counties, by the fact that no explorer mentioned the species in any other location in Texas, as well as by the very early naming of two creeks, one draining the upper part of this same area into the Red River and the other running out of the lower part of it into the Trinity River, both as Bois d'Arc creeks. I therefore submit the conclusion that this 12-county area and this alone was the natural range of this species in Texas.

The early records make it clear that the pioneers did not use the name "yellow wood" for bois d'arc but for some other. (What "yellow wood" is cannot be determined from the common name alone. In pertinent literature several species of trees are referred to by that name.) We can see this because, first, no tree found growing within the original range of bois d'arc as outlined above was called yellow wood in pre-1860 writings, and sec-

ond, because all of the yellow woods named previously to 1860 were found over 200 miles from this species' otherwise known range. Map 2 shows the discrepancy in the ranges of the pioneers' bois d'arc and yellow wood.

After reading the explorers' reports I am convinced that we have little conception of how profusely the bois d'arc grew in the center of its native haunts along the creeks named for it, so I add some of their descriptions of this.

In 1805, Sibley (1931) wrote of "a beautiful bayou situated on the left side [of the Red River]" that "the French call ... Bayou del Palo de Arco, Bois d'Arc, or Bow-wood Creek, from the large quantity of that wood that grows upon it, of which the Indians make their bows." Moore (1965) wrote of the "forests of Bois d'Arc" in the same area. Several of the surveyors described what they encountered in these areas as "thickets" of bois d'arc.

There is an especially interesting passage showing incidentally the large amount of bois d'arc that must have been in the area of Collin and Rockwall counties and at the same time showing a strange way in which these trees could have been a danger to travelers. The correspondent of the *Clarksville* [Texas] *Standard*, who signed himself merely as C De M, was traveling from McKinney down the East Fork of the Trinity in 1853 (C De M 1853). When at about the present boundary of Collin and Rockwall counties, his party had to stop for the night because "the creeks upon both sides of the river were overflowed, and although there was a ferry flat at the river, there were none at the creeks, and so we concluded to wait a few hours, as we were told that swimming the creeks might be dangerous from Bois d'Arc brush in them full of thorns—so we waited till morning, and the water rose during the night."

That the thorny branches of this species could be a real hazard and, at least upon Bois d'Arc Creek itself, could form impenetrable thickets is further emphasized by the description of one curious episode. Marryat (1970) wrote that he was struggling to get from the western wilderness to the comparative civilization of Louisiana in 1843, when he experienced the situation which he described as follows: "... after traveling some six or eight miles, we found our further progress cut off by a deep and precipitous chasm, lined with impassable briars. To return was our only alternative, and at noon we again found ourselves near to the point from whence we had started in the morning. A consultation was now held as to our future course ... On the morning of the preceding day we had passed a large, though shallow, sandy stream. Gabriel and I thought it more advisable to return to it. This stream was evidently one of the tributaries of the Red River, and was running in an easterly direction, and we were persuaded that it must flow through the chasm, and enter into the forest ... The next day at noon, we encamped on the stream ... The next morning after break-

fast, we filled our saddle-bags with the remainder of our provisions, and followed the stream for ten miles, with water to our horses' shoulders, as both sides of the river were covered with briars ... For nine miles more we continued wading down the river, till at last the prickly pears and briars receding from the banks, allowed us once more to regain the dry ground."

Anyone who has ever stumbled into and had to extricate himself from a patch of bois d'arc sprouts surely can understand why thickets of these would be virtually impassable and also why they might be called briars. And Nuttall (1980), who first named this species, attested to its growing in just such thickets as described in Texas by writing that when almost directly across the Red River from Bois d'Arc Creek in Choctaw County or western McCurtain County, Oklahoma: "... along the margin of all the rivulets we met with abundance of the Bow-wood (*Maclura*), here familiarly employed as a yellow dye." So I think that we have to make the effort to imagine at least the center of the 12-county range already outlined as a vicious, thorny, almost impassable thicket of bois d'arc instead of the open expanse it is today. Smith (1970) required this of us, having written in 1849, that "he thinks very highly of Reily's lands on the Bois d'arc, although they are covered with the dense thickets peculiar to this creek."

But this plant was not only a thorny shrub. While writing of this same general area in 1840, Moore (1965) gave something of the size of the parent trees: "The Bois d'arc trees attain a remarkable size and are often found four feet in diameter and eighty feet in height." We may class this as among the grandest of Texas' original forest trees, but it seems we should conclude that its natural range in the state was not large.

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EMANUEL D. RUDOLPH'S ROLE FOR BIOLOGICAL ABSTRACTS

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ABSTRACT

The life of Emanuel Rudolph (1927–1992), noted polar lichenologist and historian of botany, was well documented by Ronald Stuckey. Rudolph's scholarly endeavors is further revealed through his devotion to Biological Abstracts. He accepted the intellectual challenge of preparing abstracts in 1952 when a graduate student in the Henry Shaw School of Botany at Washington University. From then as a volunteer, he prepared 382 abstracts through 1977, a most exacting and time consuming task, perhaps an art. Some background on procedures at Biological Abstracts is reviewed and Rudolph's role as a volunteer abstractor for Biological Abstracts/BIOSIS is assessed.

RESUMEN

La vida de Emanuel Rudolph (1927–1992), notable liquenólogo e historiador de la botánica, que fue bien documentada por los esfuerzos eruditos de Ronald Stuckey. Rudolph, se desvela en un grado mayor a través de su dedicación a los Resúmenes Biológicos. El aceptó el reto intelectual de preparar resúmenes en 1952 cuando era estudiante en la Escuela de Botánica Henry Shaw de la Universidad de Washington. Desde entonces como voluntario, preparó 382 resúmenes durante 1977, una tarea muy exigente y laboriosa, quizás un arte. Se revisan algunos antecedentes de los procedimientos de los Resúmenes Biológicos, y se evalúa el papel de Rudolph como voluntario en la elaboración de resúmenes para los Biological Abstracts/BIOSIS.

BACKGROUND ON ABSTRACTING AT BIOLOGICAL ABSTRACTS

The practice of abstracting emerged and developed after 1790, but its roots precede the advent of printing when annotations were placed in the margins of manuscripts. Scientific journal abstracts summarize articles in a succinct manner so that researchers have a clear idea of their content, and therefore value to them. *Biological Abstracts*, one of the pre-eminent abstracting journals in the field of biology, was first published in December 1926, formed by the merger of two existing abstract indexes, *Botanical Abstracts* and *Abstracts of Bacteriology* (Manzer 1977). Some general background in the production of abstracts is explained in the preliminary pages of the January 1955 volume of *Biological Abstracts*. The distinction between *Biological Abstracts*, the serial, and Biological Abstracts, the corporate name, was con-

fusing until the corporation title was changed to BioSciences Information Service of Biological Abstracts (BIOSIS) in October 1964 (Steere 1976).

In 1928 the editors of *Biological Abstracts* relied on 3,000 scientists throughout the world to provide abstracts on a voluntary basis (Biological Abstracts 1957). At that time such a large number of volunteers was needed because the inclusion of abstracts in journals was the exception rather than the rule. Due to financial difficulties, the publication of *Biological Abstracts* nearly ended in 1936. Following the reorganization of Biological Abstracts early in 1938, appeals to the biologists of the United States for volunteer support of the publishing venture were enthusiastically met. Although a new policy had been instituted in 1937 to compensate abstractors for their work in order to speed the preparation of abstracts, collaborators were now returning their monetary compensation. Nearly a year later collaborators "advocated a policy of gratis abstracting, and the payments for abstracting were therefore discontinued" (Flynn 1951). By 1956 the number of volunteer abstractors declined to 656 people who provided 50% of the needed abstracts, while 30% of the abstracts were written by the authors of articles and forwarded by the journal editor in batches, and the remaining 20% of the abstracts were provided by office staff of Biological Abstracts or copied from published abstracts or summaries (Biological Abstracts 1957).

In the late 1960s through the mid 1970s announcements appeared in the preliminary pages of *Biological Abstracts* for the solicitation of abstractors, especially for those willing to write abstracts for taxonomic publications. One can ascertain the number of volunteer abstractors from 1959 to the present from the lists of volunteer abstractors which were published in the introductory pages of issues of *Biological Abstracts* for these years. Only 45 volunteer abstractors were listed in 1995. John Schnepp, Chief, Literature Analysis Section, Bibliographic Control Department, BIOSIS, related that this list of abstractors may be eliminated since the inclusion of author abstracts by publishers is now standard practice. (phone conversation of 7 July 1995).

The value and impact of volunteer abstractors to the success of *Biological Abstracts* did not go unsung. Appreciative of the contributions of volunteer abstractors, the administration of Biological Abstracts maintained communication with these volunteers and extended its gratitude in various ways. For many years volunteers received a Christmas greeting which summarized the year's accomplishments and progress at Biological Abstracts and also thanked the volunteers for their work. Ann Farren, Associate Bibliographer, Literature Acquisition Department, stated in her greeting of 15 December 1961 that "Our personal contacts with you have been rare, usually confined to an occasional visit to BA's booth at national and international meetings. Sometimes you may even think that we have forgotten

you. Believe me this is never true. We are reminded and say a quiet 'thank you' each time a group of your abstracts are received." Among the sentiments of thanks that were echoed on numerous occasions by BIOSIS administrators, those of Phyllis V. Parkins, Director of BIOSIS, were especially touching when she stated that "on behalf of all biologists, [we] declare our deep gratitude and appreciation to our Abstracters for the contribution they continue to make in the communication of biological information. May the sun *never* set on BA Abstracters!" (Parkins 1965). When volunteers received updated, revised instructions for the preparation of abstracts or were given new or additional assignments, expressions of gratitude were usually made. Through the years volunteers were offered publications as a token of appreciation, such as: (1) retaining issues of journals for which abstracts were being prepared, and (2) receiving a complimentary subscription to different publications produced by Biological Abstracts, through a choice of either: a sectional edition of *Biological Abstracts* (BA); *B.A.S.I.C.*, the subject index to BA; one topic of the *STANDARD PROFILE* Services; one member of the *BIORESEARCH TODAY* series; or the annual *BIOSIS List of Serials*.

EMANUEL D. RUDOLPH AS A VOLUNTEER ABTRACTOR

While a graduate student in the Henry Shaw School of Botany at Washington University and the affiliated Missouri Botanical Garden in St. Louis, Rudolph first volunteered as an abstractor for Biological Abstracts in 1952. Perhaps his major professor, Carroll W. Dodge, who was editor of the Biography, History and Bibliography section of *Biological Abstracts* since its beginning, influenced Rudolph's decision to write abstracts. Because of the broad scope of most of the journals in the 1950s and 1960s, many abstractors were assigned their work on a journal basis rather than by subject specialties. Emanuel Rudolph, however, was given abstract assignments for articles in botanical and antarctic research journals. His first assignment was to write abstracts for the Spanish language, botanical journal, *Lilloa*, most likely because he could read Spanish, was a student of botany, and had access to this journal in the Library at the Missouri Botanical Garden. In a letter to Rudolph (14 May 1952), John E. Flynn, Editor-in-Chief of Biological Abstracts, commended him for his fine abstracts. In October 1952, Dr. Flynn again wrote to Rudolph, complimenting him for his excellent abstracts and stating that such superb work was helping to build *Biological Abstracts* into an instrument of greater utility and better scholarship. He prepared abstracts for articles in volumes 16(1949)–31(1962) of *Lilloa*. Coinciding with the completion of his first assignment, Rudolph was offered, as a token of appreciation, a complimentary subscription to a Sectional Edition of *Biological Abstracts*. Whether or not Rudolph accepted

one of these sections is unknown. An itemization of the number of abstracts prepared by Rudolph for *Lilloa* and other serials is listed in Table 1 by serial title and volume.

Upon accepting a teaching position in the Department of Botany at Wellesley College, Massachusetts in the fall 1955, Rudolph wrote the editor of *Biological Abstracts* to relate that he no longer had access to *Lilloa*. After repeated correspondence to the publisher of *Lilloa*, the editor of *Biological Abstracts* succeeded in obtaining issues so Rudolph could continue to write abstracts for this journal. In fact, Rudolph was allowed to keep any issues sent to him. In June 1958 Rudolph became concerned that he had not received any copies of *Lilloa* for a long time. Apparently this was a turning point for him to accept a new abstracting assignment, for yet another Spanish language botany journal, *Anales del Instituto Botanico A.J. Cavanilles*, commencing with volume 17 (1959) and later concluding with volume 21 (1963).

In the 1960s significant changes occurred in Rudolph's professional life and in Biological Abstracts' reorganization. In the Spring of 1961 Rudolph started a new career as an Assistant Professor of Botany at The Ohio State University, Columbus, where rigorous research and an active teaching schedule occupied much of his time. These academic responsibilities would eventually diminish available time for writing abstracts. Considerable reorganization occurred at the offices of Biological Abstracts in the 1960s. Its Literature Acquisition Department saw expanded abstracting services due to the exponential increase in scientific journal publications and the computerization of operations. Ann Farren asked Rudolph in December 1961 if he would accept an additional assignment. Documentation is lacking whether Rudolph accepted another journal for abstracting when he returned from his Antarctic research expedition at the end of February 1962. Exactly three years later, Rudolph took on additional serials for abstracting. The new assignments began, and subsequently ended, with the following volumes of serials: *British Antarctic Survey Bulletin*, numbers 3 & 4(1964)–13(1967); *Commonwealth Mycological Institute. Miscellaneous Papers*, numbers 17 & 18(1964); and *Kirkia*, volumes 4(1963–64)–6, Part I(1967). Soon after these new assignments were made, another serial, *Commonwealth Mycological Institute. Mycological Papers*, which was a successor to the *CMI Miscellaneous Papers*, was added, commencing with number 99(1965) and concluding with number 141(1977).

Rudolph's busy teaching schedule and research work contributed to delays in his preparation of abstracts in the late 1960s. In fact he was unable to complete abstracts for the two Spanish language journals, *Anales del Instituto Botanico A.J. Cavanilles* and *Lilloa* because the extra time required to read these foreign language journals was not available. Rudolph reluctantly wrote

TABLE 1. Number of abstracts prepared by Emanuel D. Rudolph for Biological Abstracts, arranged by journal title.

Volume	Year	No. of Abstracts	Volume	Year	No. of Abstracts
Anales del Instituto Botanico A.J. Cavanilles			119	1969	1
17	1959	14	120	1970	1
18	1960	14	121	1970	1
19	1961	1	125	1971	1
20	1962	5	126	1971	1
21	1963	8	127	1971	1
22	1964	9	128	1972	1
	subtotal	51	129	1972	2
British Antarctic Survey Bulletin			130	1972	1
3	1964	4	131	1972	1
4	1964	0	132	1973	1
5	1965	1	134	1973	1
6	1965	4	135	1974	1
7	1965	3	136	1974	1
8	1966	5	137	1974	1
9	1966	3	138	1975	1
10	1966	2	139	1975	1
11	1967	0	141	1977	1
12	1967	1		subtotal	40
13	1967	4	Kirkia		
	subtotal	27	4	1963/64	19
Commonwealth Mycological Institute. Miscellaneous Publication			5	1966	14
17	1964	1	6(Part I)	1967	6
18	1964	1		subtotal	39
	subtotal	2	Lilloa		
Commonwealth Mycological Institute. Mycological Papers			16	1949	12
99	1965	1	17	1949	28
100	1965	1	18	1949	24
101	1965	2	19	1949	23
103	1965	1	20	1949	24
104	1966	1	21	1949	17
105	1966	1	22	1949[1951]	1
106	1966	1	23	1950	24
107	1967	1	24	1950	2
108	1967	1	25	1951[1952]	8
109	1967	1	26	1953	12
110	1968	1	27	1953[1955]	7
111	1967	1	28	1957	8
112	1967	1	29	1959	4
113	1968	1	30	1960	14
114	1968	1	31	1962	14
115	1968	1		subtotal	222
116	1969	1	Opera Lilloana		
117	1969	2	4	1962	1
118	1969	1		subtotal	1
				Grand total	<u>382</u>

to Robert Sutcliffe, Associate Bibliographer at BIOSIS (25 February 1969), that he had to return any outstanding issues of these two journals. According to Rudolph's own admission, his desire to complete abstracts was greater than his ability to write them at that time. During this same time more journals were beginning to provide author abstracts with articles, a practice becoming more commonplace. Because of this emerging practice Rudolph's abstracting assignments were cancelled for *British Antarctic Survey Bulletin* (July 1968) and *Kirkia* (April 1969).

Little documentation on Rudolph's abstracting role after 1977 is available. John Schnepf wrote Rudolph (22 September 1982) to ask if he was "still available to provide [abstracting] service in the future either for the same or for another journal." Rudolph's answer must have been affirmative as his name continued to appear in lists of volunteer abstractors in the preliminary pages of each issue of *Biological Abstracts* for 1982–1992. Even though he may not have been actively writing abstracts from 1978–1992, he was available if needed.

In the preparation of abstracts Rudolph was required to follow high standards established by the editorial staff of Biological Abstracts. Through the years guidelines, along with rules for abbreviating and acceptable abbreviations, were issued to aid the volunteer abstractor. Except for a few unsigned abstracts written in the late 1960s, Rudolph's abstracts were signed, E.D. Rudolph, and varied in length from one sentence to a whole column of text.

Emanuel Rudolph's role as an abstractor provided essential volunteer assistance at a time when Biological Abstracts was still seeking stability as a self-sustaining organization. A search in *Biological Abstracts* for articles appearing in the serials for which Rudolph prepared abstracts located 382 abstracts written by him. Through these abstracts Rudolph served his fellow biologists and the scientific community.

ARCHIVAL RESOURCES CITED AND CONSULTED

Emanuel Rudolph's archives dealing with his association with Biological Abstracts/BIOSIS are housed in the Herbarium, Museum of Biological Diversity, The Ohio State University, 1315 Kinnear Road, Columbus, Ohio 43212-1192 and curated by Dr. Ronald L. Stuckey, Professor Emeritus and Curator Emeritus, Department of Plant Biology, The Ohio State University, Columbus, Ohio.

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BOOK REVIEW

HOBBS, CHRISTOPHER. 1995. **Medicinal Mushrooms, An Exploration of Tradition, Healing, and Culture.** (Library of Congress Catalog Card Number: 95-60381, pbk, 2nd ed.). Botanica Press, 10226 Empire Grade, Santa Cruz, CA 95060, \$16.95, 251 pp, 30 color photos.

This book is carefully documented through literature sources that are discussed at the very beginning in a section entitled Sources, Historical and Scientific. This lays the groundwork for the 39 page Fungi Bibliography (900 literature sources) that is a comprehensive array of literature that traces medicinal mushrooms from the ancients to presentday. Hobbs notes that the text is divided into two parts: the first focuses on a general overview of the fungi, summarizes the history and use of medicinal fungi and gives practical instructions on how to use them. The second part is detailed and more technical, covering botany, chemistry, pharmacology, clinical studies, indications, and dosages of medicinal fungi commonly available in the United States, Asia and Europe and other parts of the world.

History of Use is a chapter packed with detailed information of medicinal uses of fungi in Western Medicine (ancient Greek writers, the herbalists, native American Indians) and uses in Asia. There is also a discussion of the origin of the words mushroom, fungus, and agaric that merit careful perusal. The chapters on Modern Uses Of Medicinal Fungi, Adaptogens and Immune Stimulants, and a Guide To Using Medicinal Fungi contain valuable information on certain species of fungi that can enhance a healthful state.

A Guide to Using Medicinal Fungi tells how to gather medicinal mushrooms, how to store them, how to prepare powdered extracts, powders, and pills, how to make teas and soups, and how to prepare tinctures and doses. Nutritional Value of Fungi (5 pages) and recipes (4 pages) discusses the nutrient content of edible and medicinal fungi.

Medicinal Fungi Monographs is devoted to 27 species of fungi. These species are discussed under the following headings: species name and author, common name, synonyms, other common names, description and habitat, range, history, chemistry, pharmacology, human clinical studies, toxicity, uses in traditional medicine, medical uses, preparation and dosage, related species, and procurement. There is a handy table entitled Overview of all Medicinal Mushroom Species that collates much of the previous information into a more simplified and retrievable tabular form. There is a short glossary of 29 mostly medical terms. Resources gives the company name and address of mushroom products. The index is incomplete for many species and common names that appear in a number of places in the text.

The modest price, wealth of information carefully gleaned from a variety of excellent sources, and nontechnical narrative directed to a lay audience, make this book a valuable addition to the professional and amateur mushroom library. One of the best bargains available today.—*Harold W. Keller, Research Associate, BRIT.*

DOCUMENTED CHROMOSOME NUMBERS
1996:1. CHROMOSOME NUMBERS
IN *CAREX* SECTION *OVALES* (CYPERACEAE)
FROM EASTERN NORTH AMERICA

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ABSTRACT

Chromosome counts for seventeen species of *Carex* section *Ovales* are reported. They range from $n=26 + IV$ to $n=40$. Counts for *Carex alata*, *C. hyalina*, *C. longii*, *C. ozarkana*, *C. reniformis*, *C. suberecta*, *C. tinctoria*, and *C. vexans* were determined for the first time and included 3 aneuploid (sensu lato) series. Four species (*C. albolutescens*, *C. hormathodes*, *C. straminea*, and *C. tribuloides*) yielded counts similar to previously published results. On the other hand, two species (*C. cumulata* and *C. silicea*) differed from previous reports and represent possible aneuploidy, while aneuploidy was demonstrated for *C. festucacea*.

RESUMEN

Se realizan recuentos cromosómicos de diez y siete especies de *Carex* sección *Ovales*. Su número varía de $n=26 + IV$ hasta $n=40$. Se realizan por primera vez recuentos de *Carex alata*, *C. hyalina*, *C. longii*, *C. ozarkana*, *C. reniformis*, *C. suberecta*, *C. tinctoria* y *C. vexans* que incluyen tres series aneuploides (sensu lato). Cuatro especies (*C. albolutescens*, *C. hormathodes*, *C. straminea* y *C. tribuloides*) dieron recuentos similares a resultados publicados previamente. Por otro lado, dos especies (*C. cumulata* y *C. silicea*) difieren de los recuentos previos y representan aneuploidia posible, mientras que se demostró la existencia de aneuploidía en *C. festucacea*.

INTRODUCTION

Carex L. section *Ovales* Kunth includes approximately 40 species in eastern North America with a deserved reputation for being taxonomically difficult. In contrast with other sections of *Carex*, Gleason and Cronquist (1991) describe species of section *Ovales* as narrowly defined and more or less confluent. In spite of there being only subtle morphological differences

between many species of this section, the karyotypes among them vary widely and reinforce the established species concepts.

Eastern North American species have haploid numbers ranging from 26 to 40 (Whitkus 1991). For some species in which multiple plants have been studied cytologically, the counts are constant. Such is the case for *C. crawfordii* Fernald (plants from 9 populations) *C. normalis* Mack. (4 plants) and *C. molesta* Mack. ex Bright (3 plants) as well as *C. cristatella* Britton, *C. projecta* Mack., and *C. tribuloides* Wahlenb. with 2 plants each (Wahl 1940; Whitkus 1991). On the other hand, other species (*C. bebbii* (L.H. Bailey) Fernald, *C. bicknellii* Britton, *C. merritt-fernaldii* Mack., and *C. tenera* Dewey) reportedly have narrow aneuploid, or more specifically, agmatoploid series. One species, the polymorphic *C. scoparia* Willd., may have a broader aneuploid series (Whitkus 1991). Two species studied thus far, *Carex festucacea* Willd. and *C. scoparia*, exhibited multivalents or univalents at meiosis metaphase I (Wahl 1940; Tanaka 1942).

The frequent aneuploidy in *Carex* is thought to be a consequence of polycentric chromosomes with diffuse centromeres (Grant 1981). If a polycentric chromosome fragments, even small chromosomal pieces have the potential of completing normal movements during mitosis and meiosis. Thus, in this particular kind of aneuploidy known as agmatoploidy, changes in chromosome number may be readily preserved. Furthermore, unlike taxa with monocentric chromosomes, these variations in *Carex* chromosome number do not effect fertility within a taxon (Whitkus 1988).

In spite of numerous chromosome studies of these species, many species of *Carex* section *Ovales* have yet to be examined cytologically. At the same time, given the known potential for variation in chromosome number within species of this section (Heilborn 1932; Wahl 1940; Tanaka 1942; Moore & Calder 1964; Packer & Whitkus 1982; Whitkus & Packer 1984; Whitkus 1991), additional counts are necessary for those species with only single or few counts. This study contributes to our understanding of karyology within section *Ovales* by reexamining 7 taxa and reporting the chromosome counts for 10 taxa for the first time.

MATERIALS AND METHODS

Living plants were collected during the flowering or fruiting season and cultivated in a sand-peat-perlite potting medium in 10–15 cm pots under greenhouse conditions. During the growing season, dilute liquid fertilizer was applied approximately monthly. Plants were cold treated (0–5° C) for 3–4 months to stimulate the production of new inflorescences.

Immature spikes were collected and preserved in methanol, chloroform, and propionic acid (6:3:2). Within the subsequent 72 hours, anthers were dissected from the spikes and squashed in 2% lactic-acetic-orcein

(Cooperrider & Morrison 1967). Meiosis I chromosome figures were examined from five or more pollen mother cells. Drawings and photographs were made with a Nikon Labophot-2 microscope using phase contrast at 1000x magnification.

Voucher herbarium specimens were typically prepared at the time of field collection. In some cases, where material was being supplied by correspondence or field material was not fruiting, voucher specimens were later prepared from greenhouse material. Vouchers, on deposit at the University of Michigan Herbarium (MICH), include drawings and photomicrographs of countable figures.

RESULTS AND DISCUSSION

The chromosome counts for the 17 taxa reported in this study ranged from $n=26 + IV$ to $n=40$ (Table 1), approximating the known range of $n=26$ to 45 for the section as a whole (Whitkus 1991). Of the 11 species for which multiple individuals were investigated, three new aneuploid (*sensu lato*) series were discovered. Of the species being reexamined, four had the same numbers as previous reports, while three others were different, indicating possible aneuploidy.

***Carex alata* Torr.** The three counts of $n=37$ are the first reported for this species. Although the plants were all collected in southwestern Michigan, the habitats sampled were diverse. The Berrien County site was a wet prairie opening, the first Kalamazoo County site (#2522) was a *Sphagnum* bog, and the second Kalamazoo County site (#2527) was a peaty *Acer rubrum* swamp. The plants varied widely in robustness with those of the *Acer rubrum* swamp having the most gracile form. Morphologically this species has the obovate perigynia of *C. albolutescens* Schwein., *C. cumulata* (L.H. Bailey) Fernald, *C. longii* Mack., and *C. ozarkana* P. Rothr. & Reznicek, all of which have lower, sometimes markedly lower, chromosome numbers. The $n=37$ is identical with that observed for *C. straminea* Willd. and *C. hormathodes* Fernald, species that also have the awned pistillate scales and stipitate achenes seen in *C. alata*.

***Carex albolutescens* Schwein.** Both of our plants, from widely differing parts of the range, had an $n=33$. Wahl (1940) reported $n=33$ for an unidentified plant from section *Ovales* which he listed as *C. sp.* 15168. Examination of his voucher specimen (at PAC) from Centre County, Pennsylvania confirmed that it is *C. albolutescens*.

This species has often been confused with *C. longii* and *C. festucea* (Rothrock 1991). The distinctive chromosome counts support the morphological analysis which indicated that these taxa are best recognized as distinct species.

***Carex bicknellii* Britton var. *opaca* F.J. Herm.** An $n=33$ was observed

TABLE 1. Chromosome number and location of species of *Carex* examined.

Species	<i>n</i>	Location: Voucher
<i>Carex alata</i> Torr.	37	Berrien Co., MI: <i>P.E.R.</i> 2531
	37	Kalamazoo Co., MI: <i>P.E.R.</i> 2522
	37	Kalamazoo Co., MI: <i>P.E.R.</i> 2527
<i>C. albolutescens</i> Schwein.	33	Berrien Co., MI: <i>P.E.R.</i> 2532
	33	Columbus Co., NC: <i>A.A.R.</i> 8972
<i>C. bicknellii</i> Britt. var. <i>opaca</i> F.J. Herm.	33	LeFlore Co., OK: <i>P.E.R.</i> 2916
<i>C. cf. brevior</i> (Dewey) Mack.	37	Garland Co., AR: <i>P.E.R.</i> 2904
<i>C. cumulata</i> (L.H. Bailey) Mackenzie	29	Newton Co., IN: <i>P.E.R.</i> 2538
	29	Hancock Co, ME: <i>A. Dibble s.n.</i>
<i>C. festucacea</i> Willd.	34	Tallahatchie Co., MS: <i>P.E.R.</i> 2944
	35	Lonoke Co., AR: <i>P.E.R.</i> 2890
<i>C. hormathodes</i> Fernald	37	Hancock Co., ME: <i>A.A.R.</i> 9162
	37	Knox Co., ME: <i>A. Dibble s.n.</i>
<i>C. hyalina</i> Boott	37	Tunica Co., MS: <i>P.E.R.</i> 2947
<i>C. longii</i> Mack.	28+IV	Berkeley Co., SC: <i>R. Wilbur</i> 52789
	31	Flagler Co., FL: <i>P.E.R.</i> 2380
	31	Indian River Co., FL: <i>P.E.R.</i> 2375B
	31	Kalamazoo Co., MI: <i>P.E.R.</i> 2525
<i>C. ozarkana</i> P. Rothr. & Reznicek	26+IV	LeFlore Co., OK: <i>P.E.R.</i> 2917
	28+III	Garland Co., AR: <i>P.E.R.</i> 2913
	31	Perry Co., AR: <i>P.E.R.</i> 2914
<i>C. reniformis</i> (L.H. Bailey) Small	40	Clark Co., AR: <i>P.E.R.</i> 2909
	40	Quitman Co., MS: <i>P.E.R.</i> 2945
	40	Stoddard Co., MO: <i>P.E.R.</i> 2936
<i>C. silicea</i> Olney	37	Hancock Co., ME: <i>A. Dibble s.n.</i>
<i>C. straminea</i> Willd.	37	Newton Co., IN: <i>P.E.R.</i> 2537
	37	Kalamazoo Co., MI: <i>P.E.R.</i> 2523
	37	Shannon Co., MO: <i>P.E.R.</i> 2928
<i>C. suberecta</i> (Olney) Britton	36	Madison Co., IN: <i>P.E.R.</i> 2314
	36	Kalamazoo Co., MI: <i>P.E.R.</i> 2528

TABLE 1. (continued.)

Species	<i>n</i>	Location: Voucher
<i>C. tincta</i> Fernald	36+IV	Penobscot Co., ME: A.A.R. 9122
<i>C. tribuloides</i> Wahlenb.	35	Lonoke Co., AR: P.E.R. 2897
<i>C. vexans</i> F.J. Herm.	33+III	Pasco Co., FL: P.E.R. 2379
	34	Hendry Co., FL: P.E.R. 2376
	35	Hillsborough Co., FL: P.E.R. 2378
	35	Indian River Co., FL: P.E.R. 2375

for this variety from the south central U.S. Previous counts of *n*=37 (Löve & Löve 1981) and *n*=38 (Tanaka 1942) were for the typical, more northerly variety. Given the strikingly different chromosomal condition, a reevaluation of the taxonomic status of this variety is being undertaken.

Carex* cf. *brevior (Dewey) Mack. This plant from the Ozark Mountains has an *n*=37. It is morphologically close to *C. brevior* and *C. molesta* but has a notably higher chromosome number. Löve and Löve (1981) reported *n*=34 for *C. brevior* and *C. molesta*. Wahl (1940) also observed *n*=34 for *C. molesta*. Our plant has the wide achenes of *C. brevior* but the rounded spike bases and ventrally nerved perigynia of *C. molesta*. Preliminary morphological evaluation suggests that this is an undescribed taxon.

Carex cumulata (L.H. Bailey) Mack. The only published count for this species (Löve & Löve 1981) is *n*=28. Our report of *n*=29 is based upon two plants from Newton County, Indiana and one from Hancock County, Maine. *Carex cumulata* is an uncommon species from barren sandy habitats with affinities to *C. longii*.

Carex festucacea Schkuhr ex Willd. Wahl (1940) reported that this species had a chromosome count of *n*=33 + III. Our material, with *n*=34 and *n*=35, showed no trivalents but does demonstrate an aneuploid series.

Carex hormathodes Fernald. Our counts of *n*=37 from plants of Maine confirmed that reported by Wahl (1940) for a plant from Rehobeth, Delaware. *Carex hormathodes* has sometimes been treated as a variety of *C. straminea* which also has *n*=37. The two seem, however, to consistently differ in habitat and in the shape of the spikes and the beak of the perigynium.

Carex hyalina Boott. The count of *n*=37 is the first for this rare species of northeast Texas, Arkansas, Oklahoma, and Mississippi. Correll and Johnson (1970) suggest that *C. brittoniana* L.H. Bailey most resembles this species. Unfortunately, no chromosome count exists for that species. *Carex hyalina* also bears some notable similarity to *C. reniformis* (L.H. Bailey)

Small. Both occur in floodplain woods and have short-creeping rootstocks, blunt pistillate scales, and perigynia with green beak and shoulders and fine papillae. On the other hand, the width of their perigynia and achenes are strikingly different.

Carex longii Mack. This widespread member of section *Ovales* represents another aneuploid series, $n=28 + IV$ and $n=31$. Our collections include individuals from the heart of its range on the Atlantic Coastal Plain as well as from the Great Lakes region. The comparatively low chromosome number compares favorably to that of *C. albolutescens* and *C. cumulata*, species with close morphological affinities to *C. longii*.

Carex ozarkana P. Rothr. & Reznicek. This newly described species, with a narrow geographic range centered on the Ozark and Ouachita Mountains of Arkansas and Oklahoma, displays limited morphological variability. Nevertheless, it has a variable chromosome condition, $n=26 + IV$, $n=28 + III$, and $n=31$. Based upon morphological considerations, Rothrock and Reznicek (1995) concluded that *Carex ozarkana* is most closely allied with *C. longii*.

Carex reniformis (L.H. Bailey) Small. This relatively distinctive member of section *Ovales* gave a constant count of $n=40$. The Clark County, Arkansas site is in the eastern Ozark Mountains, while the other two sites are within the Mississippi River embayment.

Carex silicea Olney. Two plants from a site in Hancock County, Maine gave $n=37$. Moore and Calder (1964) have previously reported $n=38$ for this species, suggesting possible aneuploidy. Mackenzie (1931) aligned *C. silicea* with other species having obovate perigynia, including *C. albolutescens*, *C. cumulata*, and *C. longii*. Compared to these species, however, *Carex silicea* has a much higher chromosome number, frequent auricula at the base of its leaf blades, moniliform inflorescences, long pistillate scales, and somewhat papillose perigynia. The relationship of this distinctive coastal sand dune species to other *Ovales* species needs further investigation.

Carex straminea Willd. in Schkuhr. All plants examined had $n=37$, including those from disjunct populations in Shannon County, Missouri and Kalamazoo County, Michigan. These counts confirm that reported by Wahl (1940) under the synonymous name *C. richii* Mack.

Carex suberecta (Olney) Britton. The two counts of $n=36$ are the first reported for this fen species. Among those species with proximate chromosome counts, *Carex hormathodes* and *C. straminea* ($n=37$) are likely the closest relatives of *C. suberecta*.

Carex tinctoria Fernald. This species is locally frequent in Maine and New Brunswick and is known from scattered localities as far west as northern Illinois, Michigan, Wisconsin, and Ontario. Its affinity with other species is unknown. The chromosome count of $n=36 + IV$ is the first for this species.

Carex tribuloides Wahlenb. Wahl (1940) and Moore and Calder (1964) reported $n=35$ for northern plants of this species. Our plant, from the southern part of the range, also has an $n=35$ but has the shorter perigynia and smaller spikes of variety *sangamonensis* Clokey.

Carex vexans F.J. Herm. The counts for this Florida endemic revealed another aneuploid series, $n=33 + III$, $n=34$, and $n=35$. *Carex vexans*, like *C. ozarkana*, links a narrow geographic distribution and relatively limited morphological variation with variable karyotypes. *Carex vexans* is probably most closely related to *C. alata*, with which it was often confused before being described as a distinctive species. Unlike *C. alata*, *C. vexans* lacks awns on the pistillate scales and its perigynia have longer, more gradually tapered beaks.

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DOCUMENTED CHROMOSOME NUMBERS 1996:2. MISCELLANEOUS U.S.A. AND MEXICAN SPECIES, MOSTLY ASTERACEAE

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ABSTRACT

Chromosome counts are reported for over eighty collections of flowering plants from the U.S.A. and Mexico, representing 59 species in 39 genera of 10 families.

RESUMEN

Se presentan recuentos cromosómicos de más de ochenta recolecciones de plantas con flores de U.S.A. y México, pertenecientes a 59 especies, de 39 géneros, de 10 familias.

The following chromosome counts (Table 1) are documented by specimens deposited at the herbarium of the University of Texas, Austin (TEX). Previously uncounted taxa are marked by an asterisk(*). A double asterisk(**) indicates a new number for the species. Fedorov (1969) and the standard indices of plant chromosome numbers published since that opus (through 1991:cf.introduction, Goldblatt & Johnson 1994) were consulted to ascertain previous counts for the taxa concerned.

METHODS

Chromosome counts were made from pollen parent cells from floral bud material collected in the field and fixed in a modified Carnoy's solution(4:3:1; chloroform, absolute ethanol, glacial acetic acid), using standard squash procedures.

DISCUSSION

Astranthium.—DeJong (1965) reported the base chromosome numbers of this genus to be $x=3$, 4, and 5. His counts for *A. splendens* ($2n=18$) are hexaploid. My counts of this species are $2n=12$ and $2n=24$, the first such counts for the species. The two counts were obtained from one head of a single plant and displayed 6 bivalents and 12 bivalents respectively.

Tradescantia.—Chromosome numbers for the five species listed in Table 1 are consistent with numbers for species of *Tradescantia* generally. Both diploidy and tetraploidy are well documented in various species of

TABLE 1. Chromosome numbers of miscellaneous U.S.A. and Mexican species, mostly Asteraceae.

Family/Species	Voucher ¹	Chromosome number(2n)
ASTERACEAE		
<i>Acamptopappus sphaerocephalus</i> (Harv. & A. Gray) A. Gray	UT:Washington T 95-127	18
<i>Aphasnostephus riddellii</i> Torr. & A. Gray	TX:Duval P 1561	10
** <i>Astranthium splendens</i> De Jong	MEX:N.L. N 7468	12,24
<i>Baileya multiradiata</i> Harv. & A. Gray	UT:Washington T 95-129	64
<i>Chaetopappa bellioides</i> (A. Gray) Shinnery	MEX:N.L. N 7591	16
<i>Chaetopappa bellioides</i> (A. Gray) Shinnery	TX:Val Verde T 95-13	16
<i>Chaetopappa imberbis</i> (A. Gray) Nesom	TX:Wilson T 94-4	16
<i>Conoclinium betonicifolium</i> (Miller) King & Robinson var. <i>betonicifolium</i> Miller	MEX:Tamp. PA 7269	20
<i>Conoclinium betonicifolium</i> (Miller) King & Robinson var. <i>integrifolium</i> Patterson	MEX:N.L. T.F. PA 7404	20
* <i>Conoclinium</i> sp. nov. T.F. Patterson (in prep.)	MEX:Tamp. PA 7308 MEX:Dur. PA 7467	20 20
<i>Coreopsis wrightii</i> A. Gray	TX: Llano Z 944	24
<i>Dyssodia pentachaeta</i> (DC.) B.L. Rob. var. <i>pentachaeta</i>	MEX:Coa. N 7650 TX:Dimmit T 94-10	ca.26 ca.26
<i>Dyssodia tenuiloba</i> (DC.) B.L. Rob. var. <i>tenuiloba</i>	TX:Fayette M 1946	26
* <i>Erigeron tenuis</i> Torr. & A. Gray	TX:Liberty M 1959	7-9 II + 22-18 I
* <i>Erigeron veracruzensis</i> Nesom	MEX:Coa. N 7486	18
<i>Gaillardia aestivalis</i> (Walt.) H. Rock var. <i>aestivalis</i>	TX:Austin T 94-86 TX:Lee T 95-69	34 34
<i>Gaillardia amblyodon</i> F. Gay	TX:Burleson T 95-88	34
<i>Gaillardia pulchella</i> Fouger. var. <i>drumondii</i> Hook.	MEX:Tamp. M 1790	34
* <i>Grindelia obvatifolia</i> S.F. Blake	MEX:N.L. N 7485	12
<i>Grindelia tenella</i> Steyerf.	MEX:Tamp. N 7451 & 7452	12
** <i>Heterotheca mucronata</i> Harms ex B.L. Turner	MEX:N.L. N 7469	36
** <i>Hymenoxys linearifolia</i> Hook.	TX:Dimmit T 94-9	30,60
<i>Machaeranthera pinnatifida</i> (Hook.) Shinnery	TX:El Paso T 94-112	8
<i>Malacothrix fendleri</i> A. Gray	AZ:Apache T 95-139	14
<i>Porophyllum gracile</i> Benth.	AZ:Mohave T 95-124	48
<i>Porophyllum scoparium</i> A. Gray	MEX:Coa. N 7689	24
<i>Psilostrophe cooperi</i> (A. Gray) Greene	AZ:Mohave T 95-125	32
* <i>Rumfordia exauriculata</i> B.L. Turner	MEX:N.L. N 7737	30
* <i>Silphium simpsonii</i> Greene var. <i>wrightii</i> Perry	TX:Liberty M 1960	14
<i>Silphium gracile</i> A. Gray	TX:Lee T 95-70	14
<i>Solidago altissima</i> L.	LA:Natchitoches N 7848	36
<i>Solidago gigantea</i> Ait.	MEX:N.L. N 7739	36
<i>Solidago velutina</i> DC.	MEX:N.L. N 7740	18
* <i>Stevia lucida</i> Lag. var. <i>oaxacana</i> (DC.) Grashoff	GUA:Que. P 1512	24

TABLE 1. (continued)

Family/Species	Voucher ¹	Chromosome number(2 <i>n</i>)
<i>Thelesperma megapotamicum</i> (Spreng.) Kuntze	MEX:Coa. N 7643	40
<i>Tridax balbisioides</i> A. Gray	MEX:Tamp. M 1839	20
* <i>Verbesina mexicana</i> Cerv. ex DC.	MEX:Tamp. PA 7306	34
* <i>Verbesina zaragosana</i> B.L. Turner	MEX:N.L. H 23514	34
* <i>Xylothamia pseudobaccharis</i> (S.F. Blake) Nesom	MEX:Coa. N 7688	18
* <i>Xylothamia riskindii</i> (B.L. Turner) Nesom	MEX:Tamp. N 7697	18
BRASSICACEAE		
* <i>Streptanthus hyacinthoides</i> Hook.	TX:Leon T 95-85	28
COMMELINACEAE		
<i>Tradescantia hirsutiflora</i> Bush	TX:Bastrop T 95-56	12
	TX:Bastrop T 95-54	12,24
	TX:Robertson T 95-71	12
<i>Tradescantia humilis</i> Rose	TX:Robertson T 95-77	12
<i>Tradescantia occidentalis</i> (Britt.) Smyth.	TX:Edwards T 95-24	12
<i>Tradescantia reverchonii</i> Bush	TX:Austin T 94-78	24
	TX:Robertson T 95-76	24
	TX:Leon T 95-86	24
* <i>Tradescantia subacaulis</i> Bush	TX:Lee T 95-52,53	12
FABACEAE		
* <i>Caesalpinea</i> (<i>Hoffmanseggia</i>) <i>oxycarpa</i> Fisher	TX:Maverick T 94-19	24
* <i>Lupinus caballoanus</i> B.L. Turner	MEX:N.L. F 9,10,11	48
* <i>Lupinus platamodes</i> C.P. Smith	MEX:Tamp. M 2084	48
<i>Lupinus texensis</i> Hook.	MEX:N.L. F 8,16, 18, & 24	36
<i>Tephrosia lindheimeri</i> A. Gray	TX:Aransas T 94-64	22
HYDROPHYLLACEAE		
<i>Phacelia integrifolia</i> Torr.	TX:Garza T 95-155	ca.24
LAMIACEAE		
<i>Brazoria arenaria</i> Lundell	TX:Jim Hogg MT 24	28
	TX:Brooks MT 25	28
	TX:Kenedy MT 26	28
* <i>Calamintha arkansana</i> (Nutt.) Shinnery	TX:Burnet MT 40	22
* <i>Scutellaria ovata</i> var. <i>mexicana</i> Epling	TX:Burnet T 94-31	ca.16
LOBELIACEAE		
<i>Lobelia appendiculata</i> A. DC.	TX:Liberty M 1958	14
PAPAVERACEAE		
** <i>Corydalis micrantha</i> (Engelm.) A. Gray	TX:Guadalupe T 94-1	12

TABLE 1. (continued)

Family/Species	Voucher ¹	Chromosome number(2 <i>n</i>)
POLEMONIACEAE		
* <i>Gilia ludens</i> Shinnery	TX:Duval P 1560	18
<i>Gilia rigidula</i> Benth.	TX:Val Verde T 95-12	36
SCROPHULARACEAE		
** <i>Capraria biflora</i> L.	MEX:Tamp. W 95-45	ca.28
* <i>Capraria frutescens</i> (Mill.) Britt.	MEX:Tamp. W 95-46	ca.28

¹The letter before the collection numbers indicates the following collectors: F(Carolyn Ferguson); H(Hinton); M(Mark Mayfield); N(Guy Nesom); P(Alan Prather); PA(Tom Patterson); T(B.L. Turner); MT(Matt Turner); W(Justin Williams); Z(Zai-Ming Zhao). * = previously uncounted taxa; ** a new number for the species.

Abbreviations for collection sites are GUA - Guatemala, MEX - Mexico, AZ - Arizona, LA - Louisiana, TX - Texas, UT - Utah, Coa. - Coahuila, Dur. - Durango, N.L. - Nuevo Leon, Tamp. - Tamaulipas, Que. = Quezaltenango. Within the U.S.A., the county is indicated; within Mexico, the state is indicated; within Guatemala, the department is indicated.

Tradescantia. In one collection of *T. hirsutiflora* from Bastrop county, Texas (T 95-54), both diploid and tetraploid pollen Parent cells were found in anthers from the same flower. Anderson (1954) reported counts of either 2*n*=12 or 2*n*=24 for various collections of *T. reverchonii*; all three collections I counted were tetraploids.

Lupinus.—The chromosome counts for *L. cabolloanus* and *L. platamodes* (2*n*=48) are consistent with most previous counts for the North American species. The four populations of *L. texensis* from Mexico are interesting in that the plants are somewhat morphologically different from populations in central Texas, and specimens of some of them were annotated as possibly new by the late Dr. D.B. Dunn. Because all of the four population I counted had 2*n*=36, a rare number for North American *Lupinus* (Turner 1994a) occurring only in the two closely related species *L. subcarnosus* Hook. and *L. texensis*, the counts reported here suggest that the Mexican populations are very closely related to the latter, if not the same.

Gilia.—Chromosome numbers in the *Gilia* sect. *Giliastrum*, to which *G. ludens* and *G. rigidula* belong, are all based upon *x*=6. Grant (1959) reported counts of 2*n*=36 for *G. rigidula*; *G. ludens* has not been counted previously and is one of only two tetraploids reported for *G. sect. Giliastrum*. All the rest are hexaploids, except for the diploid, *G. insignis* Brand (from among 9 of 17 species for which counts are now available, Turner 1994b).

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BOOK REVIEW

PRUGH, THOMAS with ROBERT COSTANZA, JOHN H. CUMBERLAND, HERMAN DALY, ROBERT GOODLAND, and RICHARD B. NORGAARD. 1995. **Natural Capital and Human Economic Survival**. (ISBN 1-887490-02-7, pbk). International Society for Ecological Economics, P.O. Box 1589, Solomons, MD 20688, \$18.95, 198 pp.

Economists use many economic indices to forecast the healthy state of world and national economies but these models fail miserably to integrate the dynamics and principles of living systems into final outcome measures. Hawken states in the foreword: "The fact that we have excluded natural capital from the balance sheet of companies, countries, and the world is an extraordinary omission and error." Our world economies have become more and more productive but at the expense of using more and more natural capital to generate energy, metals, roads, buildings and factories, infrastructure and worldwide communication systems. Our economic systems operate on the unlimited use of natural resources instead of limiting use by including life sustaining renewable resources. The authors argue for stabilization of population growth and ways to improve the productivity of natural capital. This book is about the recognition and importance and preservation of earth's natural capital. Our exploitive and extractive economy must be replaced with sustainability and renewal of natural capital. Proper evaluation of natural capital must be reflected in getting the prices right for the costs of goods and services.

There are four main sections: Section I. reviews the problems with how conventional economies treat the natural environment and describes the alternatives using ecologically based economics; Section II. describes the definition, function and valuation of natural capital; Section III. introduces some concepts and policy tools for managing natural capital for a sustainable future; the afterword poses a series of value systems such as knowing our place, thinking in circles, scaling back, taking our measure, and full empowerment. Prugh states: "We must be the change we wish to see in the world."

There is an appendix that lists some tools for personal and community action and a glossary of terms. The references are mostly from the 1980s and 1990s. This book is must reading for environmentalists who must understand ecological principles in terms of economic systems.—*Harold W. Keller, Research Associate, BRIT.*

DOCUMENTED CHROMOSOME NUMBERS
1996.3. CHROMOSOME NUMBERS IN
SOME SOUTH AFRICAN COMPOSITAE

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ABSTRACT

Observations reported here from 14 populations representing 13 species in 4 tribes of Compositae include first reports of chromosome number for *Heterolepis* (*H. aliena*; $2n = 12$, a new number for Arctoteae), for *Athanasia bremeri* ($2n = 20$, a new number for the genus), and for four species of *Ursinia* (*U. abrotanifolia*, *U. nudicaulis*, *U. pinnata*, and *U. punctata*; all $2n = 16$).

RESUMEN

Se presentan aquí las observaciones basadas en 14 poblaciones que representan 13 especies de 4 tribus de Compositae que incluyen los primeros recuentos de números cromosómicos de *Heterolepis* (*H. aliena*; $2n = 12$, un nuevo número para las Arctoteae), de *Athanasia bremeri* ($2n = 20$, un nuevo número para el género) y de cuatro especies del género *Ursinia* (*U. abrotanifolia*, *U. nudicaulis*, *U. pinnata* y *U. punctata*; todas ellas $2n = 16$).

Although chemical and numerical methods are currently in vogue, chromosome numbers continue to be important indicators of evolutionary (and taxonomic) relationships among plants (cf. Stebbins 1993). Some of the chromosome numbers reported here are first reports or are reports of new numbers for previously counted taxa and are especially likely to be important in phyletic hypotheses for the taxa from which the counts were made.

MATERIALS AND METHODS

Chromosome counts reported here were made by Strother from meiotic figures in acetocarmine-stained squashes (in Hoyer's mountant) of sporophytic (pollen parent) cells from floral buds fixed in a solution of 3 parts 95% ethanol: 1 part acetic acid (see Radford et al. 1974; Sharma and Sharma 1980). Pollens were stained with lactophenol-cotton blue; percentages were determined from 200 grains per sample. Source-plants were collected (Cape Province, South Africa, November 1994) and identified by Watson and Panero. Voucher specimens have been deposited in herbaria of Miami University (MU), National Botanic Gardens of South Africa (NBG), and University of Texas (TEX).

RESULTS AND DISCUSSION

Anthemideae

Athanasia bremeri Källersjö. $2n = 20$ (10 II, late diakinesis): Wuppertal Division, Grid 32 19 AC, Cederberg Valley, *Watson* 94-53. The count reported here is the first for the species and is a new number for the genus. Källersjö (1991) reported $2n = 16$ for eight other species of *Athanasia* and called attention to a report of $2n = 20$ for a species in the related genus *Lasiospermum* [i.e., report by Nordenstam (1967) for *L. brachyglossum* DC. from Cape Province, South Africa]. Perhaps the taxonomic position of *A. bremeri* should be reconsidered.

Cotula coronopifolia L. $2n = 20$ (10 II, late diakinesis and early first metaphase): Piketberg Division, Grid 32 18 DC, Berg River at N7, *Watson* 94-26. Numerous prior counts of $2n = 20$ and 40 have been reported for *C. coronopifolia* and diploid and/or polyploid counts based on $x = 13, 12, 10, 9$, and 8 have been reported for other cotulas (see standard indices of chromosome numbers in plants).

Oncosiphon grandiflorum (Thunb.) Källersjö. $2n = 16$ (8 II at late diakinesis, some cells with "sticky" bivalents; pollen stainability 4%): Cape Town Division, Grid 33 18 CB, Melkbostrand, *Watson* 94-23. $2n = 16$ (7 II + 2 I, 8 II, 1 chain of 4 + 6 II, late diakinesis, early first metaphase; pollen stainability 3%): Wuppertal Division, Grid 32 19 AA, on Pakhuispas, *Watson* 94-44. Mitsuoka and Ehrendorfer (1972) reported (as *Pentzia grandiflora*) $2n = 16$ for a plant from National Botanic Gardens of South Africa, Kirstenbosch. Nordenstam (1982) reported (as *Pentzia grandiflora*) $2n = 16$ for a plant grown in Lund from "Seeds from Kirstenbosch"

Oncosiphon suffruticosum (L.) Källersjö. $2n = 16$ (various configurations: 16 I, 7 II + 2 I, 2 chains of 3 + 4 II + 2 I, late diakinesis; pollen stainability 2%): Cape Town Division, Grid 33 18 CB, Melkbostrand, *Watson* 94-24. Mitsuoka and Ehrendorfer (1972) and Nordenstam (1969) reported

(both as *Pentzia suffruticosa*) $2n = 16$ for plants from National Botanic Gardens of South Africa, Kirstenbosch.

Ursinia abrotanifolia (R. Br.) Spreng. $2n = 16$ (8 II, late diakinesis): Worcester Division, Grid 33 19 CA, Bainskloofpas, *Watson* 94-68.

Ursinia nudicaulis (Thunb.) N.E. Br. $2n = 16$ (8 II, late diakinesis): Worcester Division, Grid 33 19 CA, Bainskloofpas, *Watson* 94-70.

Ursinia pinnata (Thunb.) Prassler. $2n = 16$ (8 II, late diakinesis): Wuppertal Division, Grid 32 19 AC, Cederberg Valley, *Watson* 94-51.

Ursinia punctata (Thunb.) N.E. Br. $2n = 16$ (8 II, late diakinesis): Worcester Division, Grid 33 19 AD, Michels Pass, *Watson* 94-60.

The counts reported here for ursinias are evidently first counts for the four species. Numerous counts of $2n = 16$ have been reported for other species of *Ursinia* (see standard indices). Nordenstam (1969) reported $2n = 14$ for *U. anthemoides* (L.) Poir. subsp. *anthemoides* and $2n = 16$ for *U. anthemoides* subsp. *versicolor* (DC.) Prassler. He suggested that the $2n = 14$ plants may have been derived as "... the result of a secondary reduction."

Arctoteae

Arctotis acaulis L. $2n = 18$ (9 per pole, second metaphase): Wuppertal Division, Grid 32 19 AC, Cederberg Valley, *Watson* 94-55. Ahlstrand (1979) reported $n = 9$ for a plant from the Botanical Garden of Lund identified as *A. acaulis*.

Arctotis undulata Jacq. $2n = 18$ (9 II at late diakinesis; 9 per pole, late first anaphase): Wuppertal Division, Grid 32 19 AC, Cederberg Valley, *Watson* 94-52. The count reported here is evidently the first for *A. undulata*.

Heterolepis aliena (L. f.) Druce. $2n = 12$ (6 II at late diakinesis and early metaphase): Wuppertal Division, Grid 32 19 AC, near Cederbergpas, *Watson* 94-49. The count reported here is evidently the first for *Heterolepis* and is evidently a new number for the tribe. Norlindh (1977) reported $x = 9$ and 15 for Arctotinae (to which he assigned *Heterolepis*), $x = 9$ for Gundeliinae, and $x = 5, 7$, and 8 for Gorteriinae.

Astereae

Chrysocoma longifolia DC. $2n = 18$ (9 II, late diakinesis): Clanwilliam Division, Grid 32 18 BB, 13 km from Clanwilliam town, Dwarsrivier Farm, *Watson* 94-38. Nordenstam (1967) reported $2n = 18$ for a plant (from Cape Province, South Africa) identified as *C. longifolia*.

Gnaphalieae

Leysera tenella DC. $2n = 8$ (4 II, late diakinesis; in the initial preparation from this gathering, one cell had evident chains, pairs, and univalents with sum of $2n = \text{ca. } 14\text{--}16$): Clanwilliam Division, Grid 32 18 BB, on

Pakhuispas near Kleinkiphuis, *Watson* 94-42. Bremer (1978) reported $2n = 8$ for a plant (from an unspecified site) identified as *L. tenella*.

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NOTES

RARE AND NOTEWORTHY VASCULAR PLANTS FROM THE FORT CAMPBELL MILITARY RESERVATION, KENTUCKY AND TENNESSEE

There are about 900 Department of Defense (DoD) installations scattered across the United States, ranging in size from less than two to nearly two million acres. Biological diversity on many of these sites is undocumented because the installations have been (are) off-limits to unauthorized personnel for a multitude of reasons, including safety and security. However, The Nature Conservancy and DoD are cooperating to identify, study, manage, and restore biologically and culturally significant resources on many DoD lands (Nickens 1993), including the Fort Campbell Military Reservation (FCMR) in south-central Kentucky and northwestern central Tennessee.

The FCMR occupies 105,000 acres, with approximately two-thirds of the area in Tennessee (Montgomery & Stewart counties) and one-third in Kentucky (Christian & Trigg counties). The Reservation was created in 1942 from a region that was mostly agricultural and now includes a city-like cantonment area with a variable population of about 30,000, extensive fields-forests used for various kinds of military exercises and training but with several inaccessible impact and live-fire areas, and a federal railroad right-of-way extending 20.8 km to Hopkinsville, Kentucky.

Physiographically, FCMR cuts across two subsections of the Highland Rim Section of the Interior Low Plateaus Physiographic Province as described by Quarterman and Powell (1978). The Pennyroyal Plain Subsection, occupying the central part of the Reservation, is a level-rolling karstic landscape mostly coincident with the historic "Big Barrens" Region of Kentucky and Tennessee. The remainder (western and eastern ends) is within the dissected Western Highland Rim Subsection. Drainage is by tributaries of the Cumberland River; elevations above sea level range from 122–213.5 m.

METHODS

During 102 trips from 15 March 1993–31 October 1994, and 10 trips from August–October 1995, we botanically surveyed accessible areas of FCMR, especially seeking taxa listed as elements of concern by one or both states and/or federally (Kentucky State Nature Preserves Commission 1992, herein updated to the 1995 list; Tennessee Department of Environment and Conservation 1993, herein updated to the 1994 list; U.S. Fish and

Wildlife Service 1993). The Kentucky portion of the Reservation was the responsibility of LEM, while the Tennessee portion was that of EWC and BEW. David Campbell was the Tennessee Nature Conservancy Project Manager and coordinated the study. In addition to field studies, FCMR specimens were sought in regional herbaria. Nomenclature follows Wofford and Kral (1993); distribution data cited are from Gleason and Cronquist (1991) unless otherwise noted.

RESULTS AND DISCUSSION

Listed Taxa

Twenty-one state listed species, including three candidates for federal listing, were found during field surveys. Table 1 gives these species, their FCMR county distribution, and listed rankings. Vouchers for these taxa are at one or more of: APSC, ECU, TENN, VDB. Fourteen of the 21 species are of limited occurrence and thus listed elements in Kentucky or Tennessee because these states are peripheral to their range. Most of these species are abundant elsewhere (*Prenanthes barbata* and *Tomanthera auriculata*, rare throughout their ranges, are exceptions).

Floristic affinities of the 14 extraneous taxa are shown when they are grouped according to their distributional locus in relation to FCMR. The extent of FCMR populations is parenthetically noted. Seven taxa have western-northwestern distributions: *Aster paludosus* ssp. *hemisphericus* (infrequent at one site), *Hieracium longipilum* (abundant at several sites), *Muhlenbergia glabrifloris* (large stands at several sites), *Prenanthes aspera* (a few plants at one site), *Rudbeckia subtomentosa* (abundant at several sites), *Silphium laciniatum* (abundant at several sites), and *Tomanthera auriculata* (abundant at several sites). Six southern taxa include *Carex alata* (abundant at one site), *Gymnopogon ambiguus* (a few plants at six sites), *Malus angustifolia* (a few trees at one site), *Oenothera linifolia* (abundant in the Tennessee portion, rare in Kentucky), *Prenanthes barbata* (scattered individuals), and *Scleria ciliata* (abundant at one site). *Populus grandidentata* (several trees at one FCMR site) is a northern species.

The remaining seven species are basically intraneous in distribution. *Phacelia ranunculacea* (abundant at two sites) has three centers of distribution, Atlantic Coastal Plain of Virginia and Maryland, the Piedmont of North Carolina, and the Mississippi Embayment and adjacent provinces of several states; it is locally abundant but occurrences are scattered to rare (Chuang & Constance 1977). *Silphium pinnatifidum* Elliott [*S. terebinthinaceum* Jacq. var. *pinnatifidum* (Ell.) A Gray] (abundant at several sites) is found only in Alabama, Georgia, Kentucky, and Tennessee (Fisher & Speer 1978)

TABLE 1. Listed taxa known from the Fort Campbell Military Reservation, Kentucky and Tennessee, their known county distribution at FCMR¹, and their Kentucky and Tennessee², National³, and Global Status⁴.

Taxa	Distr.	KY	TN	Nat.	Global
<i>Aster paludosus</i> Ait. ssp. <i>hemisphericus</i> (Alex.) Cronq. ROUND-HEAD ASTER (Asteraceae)	T	E	—	—	G 5
<i>Carex alata</i> Torrey WINGED-FRUITED SEDGE (Cyperaceae)	C	T	—	—	G 5
<i>Carex decomposita</i> Muhl. CYPRESS-KNEE SEDGE (Cyperaceae)	M	T	—	—	G 5
<i>Gymnopogon ambiguus</i> (Michx.) BSP. BEARDGRASS (Poaceae)	C,M	S	—	—	G 5
<i>Hieracium longipilum</i> Torrey LONG-HAIRED HAWKWEED (Asteraceae)	M,S,T	T	S	—	G4/G5
<i>Hydrastis canadensis</i> L. GOLDENSEAL (Ranunculaceae)	M,S	—	T	—	G 4
<i>Juglans cinerea</i> L. WHITE WALNUT (Juglandaceae)	S	S	T	C2	G3/G4
<i>Malus angustifolia</i> (Aiton) Michx. SOUTHERN CRABAPPLE (Rosaceae)	C	S	—	—	G 5
<i>Muhlenbergia glabrifloris</i> Scribn. SMOOTH MUHLY (Poaceae)	C,T	S	S	—	G 4
<i>Oenothera linifolia</i> Nutt. THREAD-LEAVED SUNDROPS (Onagraceae)	C,M,S,T	E	—	—	G 5
<i>Panax quinquefolius</i> L. GINSENG (Araliaceae)	M,S	—	T	—	G 4
<i>Phacelia ranunculacea</i> (Nutt.) Const. BLUE SCORPIONWEED (Hydrophyllaceae)	M	S	S	—	G 4
<i>Platanthera peramoena</i> (Gray) Gray PURPLE FRINGELESS ORCHID (Orchidaceae)	M	—	T	—	G 5
<i>Populus grandidentata</i> Michx. BIG-TOOTH ASPEN (Salicaceae)	M	—	S	—	G 5
<i>Prenanthes aspera</i> Michx. ROUGH RATTLESNAKE ROOT (Asteraceae)	T	E	E	—	G 4
<i>Prenanthes barbata</i> (T.&G.) Mil. RATTLESNAKE ROOT (Asteraceae)	M	E	S	C2	G2/G3
<i>Rudbeckia subtomentosa</i> Pursh SWEET CONEFLOWER (Asteraceae)	C,M,S,T	E	T	—	G 5
<i>Scleria ciliata</i> Michx. NUTRUSH (Cyperaceae)	T	E	—	—	G 5
<i>Silphium laciniatum</i> L. COMPASS-PLANT (Asteraceae)	M,S,C	E	T	—	G 5
<i>Silphium pinnatifidum</i> Elliott PRAIRIE DOCK (Asteraceae)	M	—	T	—	G 3
<i>Tomanthera auriculata</i> (Michx.) Raf. EARLEAF FOXGLOVE (Scrophulariaceae)	M	— ⁵	E	C2	G 2

¹Known county distribution at FCMR given as: C = Christian Co., KY; M = Montgomery Co., TN; S = Stewart Co., TN; T = Trigg Co., KY.
²E = endangered, T = threatened, S = special concern.
³C2 = a candidate for federal listing.

¹Global rankings: G2 = imperiled globally because of rarity or because of some factors making it very vulnerable to extinction throughout its range; G3 = either very rare and local throughout its range or found locally (even abundantly) in a restricted range, or because of some other factors making it vulnerable to extinction throughout its range; G4 = apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery; G5 = demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery.

⁵*Tomanthera auriculata* is not known from Kentucky and thus not listed there.

and is infrequent to rare throughout its range. *Carex decomposita* (numerous clumps at one site) and *Platanthera peramoena* (several small populations) range over much of eastern U.S., but are infrequent to rare in occurrence. *Juglans cinerea* (five trees and numerous juveniles at one site) also is wide-ranging in eastern U.S., but is in general decline and now extirpated from several areas (Anderson & LaMadeleine 1978; Rink 1990). Lastly, *Hydrastis canadensis* (several large populations) and *Panax quinquefolius* (several small populations), are wide-ranging but rare, primarily because of loss of habitat and commercial exploitation.

State Records

Two non-native taxa new to the known flora of Tennessee were found.

Nymphoides peltata (Gmel.) Kuntze (YELLOW FLOATING-HEART, Menyanthaceae) is a rooted, floating-leaved aquatic native to southern Europe and Asia Minor. It was introduced into this country for cultivation in garden pools, but has become sporadically naturalized over much of eastern U.S. However, it has not been reported for states south of Virginia or east of Louisiana, Arkansas, and Missouri (Godfrey & Wooten 1981). This report, based on an extensive population in a Reservation pond, adds not only the species but also the genus and family to the known Tennessee flora.

Voucher specimens: TENNESSEE. Montgomery Co.: pond by FCMR golf course, 19 Jun 1993, *Wofford* 93-23 (TENN); 6 Jun 1994, *Chester* 13040 (APSC).

Richardia brasiliensis (Moq.) Gomez (without vernacular, Rubiaceae) is a diffuse, pilose annual or perennial native to South America. It has become a naturalized weed, primarily on the Coastal Plain from Texas to Florida and northward to Virginia. FCMR plants were in sandy soil of a disturbed field where rareness indicates that it is either a recent introduction or is slow to become naturalized in the area.

Voucher specimen: TENNESSEE. Montgomery Co.: FCMR, field on N side of Oriental Village Road at junction with Hellcat Road, 20 Oct 1994, *Wofford & Chester* 13150 (TENN).

Other Noteworthy Taxa

Two FCMR taxa are noteworthy because of their limited distribution in Tennessee.

Phragmites australis (Cav.) Trin. ex Steud. (REED-GRASS, Poaceae) is often weedy and occurs over much of the U.S. except for several southern states. Previous Tennessee reports are from Henry County, northern west Tennessee (DeSelm et al. 1994).

Voucher specimen: TENNESSEE. Montgomery Co.: beaver-formed marsh at jct of Jordan Springs Road and Oriental Village Road, FCMR, 28 Aug 1993, *Wofford & Chester* 12996 (APSC, TENN, VDB).

Psoralea onobrychis (Nutt.) Rydb. (SCURF-PEA, Fabaceae) ranges from Ohio and Kentucky to Iowa and Missouri, and also is found in West Virginia, Tennessee, and South Carolina. Isely (1990) reported it from one county each in North Carolina, South Carolina, and Virginia, and from two counties in Tennessee, noting that "material seen for reports from NC and TN is represented only by collections from the last century." The FCMR collection is from a dense stand of several hundred plants along a roadside-barren.

Voucher specimen: TENNESSEE. Montgomery Co.: barrens on N side of Ghost Corp Trail one mile E of Palmyra Road, FCMR, 2 Jul 1993, *Chester* 12985 (APSC, TENN, VDB).

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A REPORT OF FOUR EXOTIC *CYPERUS* (CYPERACEAE)
SPECIES NEW TO FLORIDA, U.S.A.

Cyperus alopecuroides Rottb., *C. distans* L.f., *C. prolifer* Lam., and *C. sphacelatus* Rottb. are reported new to Florida. All four taxa are exotic weeds and appear to be naturalized. *Cyperus alopecuroides*, *C. distans*, *C. sphacelatus* are newly introduced, and *C. prolifer* is apparently recently naturalized. This report of *C. alopecuroides* is the second for the western hemisphere. General distributional data and pest potential are discussed. Each taxon is compared with similar species, and collection data are given.

In the past decade a number of *Cyperus* species have been reported new to Florida: *C. difformis* L., *C. echinatus* (L.) Wood, *C. entrerianus* Böckeler, *C. bystricinus* Fernald, *C. pilosus* Vahl, and *C. reflexus* Vahl (Burkhalter 1984, 1985; Carter 1988, 1990; Carter & Jones 1991; Anderson 1991). Recently, specimens from central and southern Florida have been identified as *Cyperus alopecuroides* Rottb., *C. distans* L.f., *C. prolifer* Lam., and *C. sphacelatus* Rottb. *Cyperus alopecuroides*, *C. distans*, and *C. sphacelatus* are apparently casual introductions, and *C. prolifer* is likely an escape from cultivation. All four species are weeds (Reed 1977; Häffliger et al. 1982) with potential to become pests in other subtropical areas of the southeastern United States, and all appear to be naturalized in Florida. None has previously been reported from Florida (Ward 1968; Long & Lakela 1971; Godfrey & Wooten 1979; Wunderlin 1982; Clewell 1985), and only *C. distans* (Small 1933; Kükenenthal 1935; Radford, Ahles & Bell 1968; Beal 1977; Kartesz 1994) and *C. sphacelatus* (Mohr 1901; McGivney 1938) have previously been reported from the United States.

Cyperus alopecuroides Rottb., Descr. Pl. Rar. Progr. 20. 1772.

Cyperus alopecuroides is widely distributed in tropical and subtropical regions of the Old World, e.g., northern and tropical Africa, Madagascar, India, Ceylon, Indo-China, Malaysia and northern Australia; in the New World it is known only from Guadeloupe in the West Indies (Kükenenthal 1936; Koyama 1985).

In habit and general inflorescence pattern, *C. alopecuroides* resembles the tropical species *C. imbricatus* Retz., and both taxa were placed in section *Exaltati* by Kükenenthal (1935). Its foliage and stout reddish base somewhat resemble those of *C. erythrorhizos* Muhl. *Cyperus alopecuroides* is a robust aquatic to 1.5 m high. Its size in combination with other characters make it a striking plant in the field: broad bracts and leaf blades (to 15 mm wide) with contrasting surfaces (adaxial light-green, abaxial glaucous), and a branched inflorescence with spikes of densely clustered golden-brown spike-

lets. Although its affinities are clearly with subgenus *Cyperus* (Kükenthal 1935; Koyama 1985), it has characteristics that seem to defy placement there: namely, a bicarpellate gynoecium with two stigmas and a lenticular achene with face adjacent to rachilla. When taken alone, the gynoecium and fruit characteristics seem to indicate a relationship with subgenus *Juncellus* (Clarke 1908). However, Koyama (1985) has observed both bi- and trigynous pistils in the same inflorescence, and this, in combination with other characteristics, supports inclusion of *C. alopecuroides* in subgenus *Cyperus*. Illustrations of *C. alopecuroides* are in Häffliger et al. (1982, p. 46: as *Juncellus alopecuroides*) and Haines & Lye (1983, p. 181, Fig. 348).

In Florida, *C. alopecuroides* was growing as an emergent in a reclamation wetland in an abandoned phosphate pit, where it was locally abundant in floating mats and was less common in shallow water along the wetland edges. Associated taxa include *Eleocharis interstincta* (Vahl) R. & S., *Sagittaria* sp., and *Scirpus californicus* (Meyer) Steud. This exotic *Cyperus* may have been introduced as a contaminant in nursery stock used for revegetation and has probably been in place at least two years (Tom Nix, IHS Environmental Consultants, pers. comm. 1994). Several hundred plants were observed in an area of about six ha. The plant's ability to form extensive stands and floating mats here suggests invasive potential should it escape from the reclamation site. Close monitoring is called for in the area. The following data are for first collections from Florida and the United States.

Voucher specimens: U.S.A. FLORIDA. Polk Co.: ca. 3 mi W of Fort Meade, N from county road 630 on dirt road by Tiger Bay, reclamation wetland #SP-6 on U.S. Agrichem property, NW 1/4 Sec 30, T31S R25E, 15 Sep 1993, T. Nix with M. Phillips s.n. (FSU, fragment and photocopy at VSC); 11 Feb 1994, Carter 11605 with Mears & Phillips (FSU, SWSL, VSC, others to be distributed); 24 May 1995, Burks 1018 with Nix, Phillips & Fiesler (FSU, VSC).

***Cyperus distans* L.f., Suppl. pl. 103. 1781.**

Cyperus distans is a pantropical weed inhabiting marshes, canal banks and ditches in Africa, India, Sri Lanka, southeastern Asia, Malaysia, southern China, the Philippines, the Caribbean islands, central America, Mexico, and tropical South America (Clarke 1900; Uittien 1932; Kükenthal 1935; Koyama 1985; Adams 1994; Tucker 1994). *Cyperus distans* is rare in southeastern United States, where it has been reported from coastal North Carolina (Kükenthal 1935; McGivney 1938; Radford, Ahles & Bell 1968; Beal 1977) and from Georgia (Small 1933; Kükenthal 1935; Beal 1977). The citations of *C. distans* from Georgia are doubtful; neither have we seen specimens nor was it reported by Jones & Coile (1988).

Cyperus distans has trifid styles and trigonous achenes and, in habit, re-

sembles *C. odoratus* L. or *C. stigosus* L., from which it can be distinguished by its looser spikes and more delicate spikelets. The following combination of characteristics distinguishes *C. distans* from all other North American *Cyperus*: scales ascending, remote, with 3-5 nerved greenish keels, sanguineous to reddish brown nerveless sides, and scarious emarginate tips. *Cyperus distans* is illustrated in Häffliger et al. (1982, p. 17) and in Beal (1977, p. 117). The following data provide the first documentation of *C. distans* from Florida.

Voucher specimens: U.S.A. FLORIDA. St. Lucie Co.: ca. 8 mi E of Okeechobee Co. line on FL 68, ca. 9 mi W of Ft. Pierce, T35S R38E Sec. 9, 26 Sep 1985, Wunderlin, Hansen & van Hoek 10138 (TENN, pers. herb. C.T. Bryson, fragment and photocopy at VSC).

Cyperus prolifer Lam., Ill. I.147. 1791.

Cyperus prolifer inhabits marshes, marshy shores, and swampy stream banks in eastern Africa (Kükenthal 1935; Bailey & Bailey 1976; Haines & Lye 1983). *Cyperus prolifer* is commonly known as dwarf papyrus or miniature papyrus and is sold as an ornamental for use in water gardens (Bailey & Bailey 1976). It has been variously listed as *Cyperus haspan viviparus* (Watkins & Sheehan 1975; Graf 1985), *C. papyrus* cv. "nanus" (Bailey & Bailey 1976), and *C. isocladius* Kunth (Bailey & Bailey 1976; Everett 1981). Illustrations of *C. prolifer* are in Kükenthal (1935, p. 11, Fig. 2A) and Haines and Lye (1983, p. 171, Fig. 327).

In addition to the typical variety of *C. prolifer*, Kükenthal (1935) recognized *C. prolifer* var. *isocladius* (Kunth) Kükenthal (= *C. isocladius* Kunth). According to Kükenthal (1935), in var. *isocladius* the culm is trigonous and apically triquetrous and scabrid, while in the typical variety the culm is terete and apically obtusely trigonous and smooth. Our Floridian plants are consistent with Kükenthal's concept of *C. prolifer* var. *prolifer*. In habit *C. prolifer* superficially resembles *C. haspan* L., and Kükenthal (1936) classified both species in section *Haspani*. *Cyperus prolifer* can be readily distinguished from *C. haspan* by its thick rhizome and inflorescence of 50–100 rays, with the rays of more-or-less uniform length.

In central Florida *C. prolifer* has apparently escaped from cultivation and is found growing in floating mats and occasionally along margins of natural limesink lakes, where it is associated with *Oxycaryum cubense* (Poepp. & Kunth in Kunth) Lye [= *Scirpus cubensis* Poepp. & Kunth in Kunth]. The landowner of lakefront property adjacent to an infested area of Lake Huntley indicated "dwarf papyrus" had been cultivated there in a water garden for about eight years and that during that period it had spread into the lake where it had become an invasive pest (M. Hout, pers. comm. 1994). In

1991 the landowner sought and obtained a control permit from the Florida Department of Environmental Protection (FDEP), which allowed hand-removal or treatment with glyphosate (trademark Rodeo). After two years of growing-season treatment, the original Lake Huntley population was greatly reduced in size. However, several other colonies have been found on the lake (David Demmi, FDEP, pers. comm. 1994). This population and others found more recently in nearby Lake Francis and Lake Lotela and in Lake Howard should be monitored, and the species sought in systematic routine surveys in central Florida lakes. If *C. prolifer* continues to spread from cultivation, it should probably be placed on the state list of prohibited aquatic plants (Ramey 1990). The following data provide documentation for *C. prolifer* in Florida.

Voucher specimens: U.S.A. FLORIDA. Highlands Co.: city of Lake Placid, W and E sides of southernmost shore of Lake Huntley, just W of jct of Holmes Avenue and county road 29, SE 1/4 Sec. 8, T36S R29E, 6 Jul 1993, *D. Demmi s.n.* (FSU, VSC); 5 Oct 1993, *D. Demmi s.n.* (FSU, VSC); 13 Feb 1994, *Carter 11640 & Mears* (FSU, SWSL, VDB, VSC, others to be distributed); shore of Lake Francis, W of Hwy. US 27, ca. 3 mi N of city of Lake Placid, N 1/2 Sec 22, T36S R29E, 14 Sep 1993, *D. Demmi s.n.* (FSU, VSC); along NW shore of Lake Lotela near boat ramp near jct of hwy SR 17 and CR 17A, in city of Avon Park, NW 1/4 Sec. 28 T33S R28E, 2 Nov 1994, *D. Demmi s.n.* (FSU). Polk Co.: Winter Haven, N shore of Lake Howard between Lake Howard Drive NW and shore of lake, locally common between 8th St NW and Mirror Terrace, 24 May 1994, *Mears 94-30* (VSC).

***Cyperus sphacelatus* Rottb., Descr. Pl. Rar. Progr. 21. 1772.**

Cyperus sphacelatus is a widely distributed tropical and subtropical taxon, known from eastern Africa, Ceylon, Malaysia, northern Australia (Queensland), Tahiti, South America, Central America, and the Caribbean (Clarke 1900; Britton 1907; Uittien 1932; Kükenthal 1936; Haines & Lye 1983; Tucker 1983; Koyama 1985). Mohr (1901) reported *C. sphacelatus* from ballast heaps in Mobile, Alabama, and McGivney (1938, p. 51) cited it among excluded taxa. Reed (1977) listed *C. sphacelatus* as an economically important foreign weed with potential for becoming a problem in the United States. Additional field work is needed to determine its total range in southern Florida and its pest potential there.

Although *C. sphacelatus* is a distinctive taxon, it might be confused with *C. esculentus* L., *C. filicinus* Vahl, or *C. rotundus* L., with which it bears a superficial similarity. The following combination of characteristics readily distinguishes *C. sphacelatus* from other North American *Cyperus* spp.: annual cespitose habit; triquetrous achene; diffuse inflorescence with flattened spikelets; and variegated floral scales pale, nearly white, each with two conspicuous reddish patches. Illustrations of *C. sphacelatus* are in Häffliger

TABLE 1. Geography and variation in scale length in *Cyperus sphacelatus*.

Location	Scale length	Specimen or reference citation
Florida, U.S.A.	2.0–2.8 mm (mean=2.48, N=50)	<i>Carter 11627 & Mears</i>
Dominican Republic	2.25–2.6 mm (mean=2.43, N=25)	<i>Carter 5190 & Garcia</i>
Cameroon	2.4–2.8 mm	<i>Goetghebeur 4908</i>
Tanzania	2.4–2.8 mm	Haines & Lye (1983)
Ceylon	2.0–2.8 mm	Koyama (1985)
Costa Rica and Panama	(2.2–)3.0–4.0(–4.4) mm	Tucker (1983)
Central America	2.5–4.0 mm	Adams (1994)

et al. (1982, p. 25), Haines & Lye (1983, p. 195, Fig. 383), and Reed (1977, p. 180).

The floral scales are longer in Central American specimens than in West Indian ones (Tucker 1983). Scale length in our Floridian specimens ranges from 2.0 to 2.8 mm, well within the range seen in West Indian specimens and mostly shorter than reported from Central America (see Table 1). Thus, *C. sphacelatus* was likely introduced into Florida from the West Indies.

The habitat of *C. sphacelatus* was described by Reed (1977) as “disturbed ground, in damp, grassy places” and by Tucker (1983) as “beaches, shores of rivers, moist thickets, fields, and disturbed sunny sites.” In southern Florida, *C. sphacelatus* is a locally common heliophyte in moderately well drained soil along an open, sloping road berm adjacent to a swamp, where it is associated with *Amaranthus spinosa* L., *Ambrosia artemisiifolia* L., *Argemone mexicana* L., *Bidens alba* (L.) DC., *Catharanthus roseus* (L.) G. Don, *Chamaesyce byssopifolia* (L.) Small, *Chromolaena odorata* (L.) King & Robins., *Conoclinium coelestinum* (L.) DC., *Cyperus filicinus* Vahl, *C. polystachyos* Rottb., *C. surinamensis* Rottb., *Dactyloctenium aegyptium* (L.) Beauv., *Eclipta alba* (L.) Hassk., *Emilia fosbergii* Nicols., *Erechtites hieracifolia* (L.) Raf., *Kyllinga brevifolia* L., *Macroptilium lathyroides* (L.) Urban, *Parthenium hysterophorus* L., *Pennisetum* sp., *Physalis* sp., *Pluchea odorata* (L.) Cass, *Poinsettia cyathophora* (Murr.) Kl. & Gke., *P. heterophylla* (L.) Kl. & Gke., *Ricinus communis* L., *Scoparia dulcis* L., *Sida acuta* Burm. f., *Sorghum halepense* (L.) Pers., *Stachytarpheta jamaicensis* (L.) Vahl, *Trema micrantha* (L.) Blume, *Tridens flavus* (L.) Hitchc., and *Urena lobata* L. The following data provide documentation for *C. sphacelatus* in Florida.

Voucher specimens: U.S.A. **FLORIDA**. **Dade Co.:** 0.58 mi S of jct hwys US 41 and FL 997, shoulder of hwy FL 997, edge of swamp, locally common, 12 Feb 1994, *Carter 11627 & Mears* (FSU, SWSL, VSC, others to be distributed); 1.58 mi S of jct hwys US 41 and FL 997, shoulder of hwy FL 997, edge of swamp, locally common, 25 Dec 1993, *R.L. Mears s.n.* (VSC); 12 Feb 1994, *Carter 11634 & Mears* (FSU, SWSL, VSC, others to be distributed). **Hillsborough Co.:** E of jct Dale Mabry Drive and Lakeview Drive, 0.35 mi

N jct Lakeview Drive and Lake Heather Drive by Lake Heather Drive, along E side of Lake Heather Drive, 10 Dec 1994, *K. Holland & R.L. Mears s.n.* (VSC).

Other specimens examined: **DOMINICAN REPUBLIC.** Distrito Santo Domingo: a orilla del Rio Manoguayabo, en el poblado de Manoguayabo, 12 Dec 1986, *Carter 5190 & Garcia* (VSC). **CAMEROON.** Litt. Prov.: Loum Chantiers, Moungo River beds, near large bridge, 5 km NW of Ebonji, 27 Mar 1983, *Goetghebuer 4908* (VSC).

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CYPHOMERIS GYPSOPHILOIDES VAR. *STEWARTII* A SYNONYM
OF A VARIABLE *C. GYPSOPHILOIDES* (NYCTAGINACEAE)

In a recent paper, Mahrt and Spellenberg (1995) reported upon multivariate analyses of the small genus *Cyphomeris*, and provided a taxonomy that recognized only two variable species, *C. crassifolia* (Standl.) Standl. and *C. gypsophiloides* (Mart. & Gal.) Standl. One of the goals of that study was to search for geographically coherent series of populations that might be worthy of taxonomic recognition. Overall, such structure in the genus was determined to be weak at best. In that paper they noted that both taxa were variable, particularly the latter, and that *C. gypsophiloides* var. *stewartii* I.M. Johnston was statistically somewhat peripheral to groups of populations or individuals produced by cluster analyses or principal components analysis, but was not clearly distinct nor any more distinct in these analyses than other isolated and moderately differentiated populations. By innuendo it is apparent that they believed that *C. gypsophiloides* var. *stewartii* was not worthy of infraspecific recognition, but unfortunately in the taxonomy provided, this name was omitted from synonymy. Although cumbersome by doing now, I wish to explicitly indicate to future workers that we do not recognize this variety to be distinct from *C. gypsophiloides* when recognized as a variable taxon composed of numerous semi-isolated populations differentiated from one another to varying degrees. The holotype, *R.M. Stewart* 1943, Chihuahua, large canyon near northeast end of Sierra Diablo, 29 Jul 1941, GH! (J. Arnold Arbor. 25:173. 1944) was used in the analyses.—*Richard Spellenberg, Department of Biology, New Mexico State University, Las Cruces, NM 88003-8001, U.S.A.*

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RESULTS OF A FIELD SURVEY FOR *CYPERUS GRAYOIDES* (CYPERACEAE) IN ARKANSAS

A field survey for *Cyperus grayoides* Mohlenbrock was conducted in Arkansas in 1995. In 138 locations surveyed, seven populations were found in two counties. Six populations are new discoveries. All populations were found on Agala loamy sand soils.

Cyperus grayoides Mohlenbrock (Cyperaceae) is an obscure member of *Cyperus* section *Laxiglumi*. It has been reported previously from Illinois, Missouri, Texas, and Louisiana, and more recently from Arkansas. In Texas and Louisiana, *C. grayoides* is found on communities variously described as sandhill woodland, pine barrens, xeric riparian sandhills, and deep sand savanna. In Missouri the habitat is sand prairie on the Scotco sandridges of the southeastern lowlands. The original Arkansas location is a barrens area in loose eroding sand of the Agala soil association (Bridges & Orzell 1989; Carter & Bryson 1991; Logan 1994).

The purpose of this paper is to document additional Arkansas locations of *C. grayoides*, to assess its habitat preferences in Arkansas, and to suggest where future survey work may reveal still more populations of the species.

METHODS

A total of 138 sites were surveyed in the field during August and September of 1995. Survey sites were in northeastern Arkansas near the Missouri populations of *C. grayoides*, including Crowley's Ridge and Mississippi Embayment; southwestern Arkansas near the Texas and Louisiana populations; and south-central Arkansas with extensive sand barren communities and the original Arkansas location of *C. grayoides*. Additionally, it was suggested (Paul McKenzie, pers. comm.) that dune soils of the Western Lowlands of the Mississippi Embayment (between Crowley's Ridge and the Ozark Escarpment) might contain populations of this sedge (Table 1).

Because of habitat requirements of *C. grayoides*, only sites with sandy soils were surveyed. In Miller and Lafayette counties Briley loamy fine sand was the only sandy soil (Laurent 1984). In northeastern Lafayette County, areas of Bowie fine sandy loam were examined due to reports of sandhill communities in that area. No appropriate soils were found in Ashley, Bradley, Calhoun, Columbia, or Union counties of southern Arkansas.

In Ouachita and Nevada counties in south-central Arkansas, Agala loamy sand was surveyed because sand barren communities are known on this soil type. No appropriate soils were found in Clark County.

In Mississippi County of northeastern Arkansas, the only appropriate soil is Steele loamy sand (Ferguson & Gray 1971). However, examination

TABLE 1. Summary of areas, counties, site types, and soil types surveyed for *Cyperus grayoides*.

Area/county	Types of sites/Communities	Soils
I. Mississippi Embayment Mississippi Co.	fields	Steele loamy sand
II. Crowley's Ridge Greene Co. Clay Co. Craighead Co	seeps & associated sites seeps & associated sites seeps & associated sites	no particular type no particular type no particular type
III. Western Lowlands of Mississippi Embayment Clay Co. Monroe Co. Randolph Co. Lawrence Co. Jackson Co. Woodruff Co.	cemeteries cemeteries cemeteries cemeteries cemeteries cemeteries	dune/swale areas dune/swale areas dune/swale areas dune/swale areas dune/swale areas dune/swale areas
IV. Southwest Arkansas Miller Co. Lafayette Co.	cemeteries, forests, sand cemeteries, forests, sand	Briley loamy fine Briley loamy fine Bowie fine sandy loam
V. South-central Arkansas Nevada Co. Ouachita Co.	cemeteries, forests, sand cemeteries, forests, sand	Agala loamy sand Agala loamy sand

of soil maps showed this soil only in small, narrow deposits, all of which were included in agricultural fields. Thus, it was concluded that no native vegetation remained, and Mississippi County was eliminated from further consideration.

In the Crowley's Ridge counties of Greene, Clay, and Craighead, no sandy soils are mapped (Robertson 1969; Fielder et al. 1978; Ferguson 1979). However, eroded areas of the ridge have small outcrops of sand and gravel. Since the sandhill communities of south-central Arkansas are often associated with springs and seeps, known seep locations were used to identify potentially sandy areas on Crowley's Ridge.

Intensive agriculture in the Western Lowlands of the Mississippi Embayment has replaced native vegetation on the dune-associated soils, and where native flora remains the soils are generally too wet for agriculture, e.g., wooded sandpond areas. Thus, cemeteries were the primary survey sites in the Western Lowlands.

RESULTS

Seven populations of *C. grayoides*, including the original state record reported by Logan (1994), were found in Nevada and Ouachita counties of south-central Arkansas. All populations occur on Agala soils, most with enough slope to produce active erosion. In addition, 131 other locations, ranging in size from fractions of a hectare to several sections, were surveyed with negative results.

Although occasionally the sandhill indicator *Froelichia floridana* (Nutt.) Moq. can be seen along roadsides, very little dry sand community vegetation remains in the Western Lowlands. Most cemeteries tended to be too highly altered for native species to persist, and Bermuda grass (*Cynodon dactylon* (L.) Pers.) the most common species in them. The few abandoned cemeteries surveyed either were densely wooded or were surrounded by agricultural fields and had become dominated by weeds such as *Setaria* spp., *Polygonum* spp., and Johnson grass (*Sorghum halepense* (L.) Pers.).

Crowley's Ridge proved no better for sandhill species. One location with *Aristida lanosa* Muhl. ex Ell., a sandhill species, was inspected; however, this site was densely wooded except for occasional highly disturbed areas.

In southwestern Arkansas, most sites with Bowie and Briley soils were dominated by dense, brushy secondary successional forests. Such habitats with dense canopies proved unsuitable for *C. grayoides*. Additionally, few cemeteries were found on these soils and no sandhill species were found in those surveyed. Also an inspection of Miller County Sandhills Natural Area and surrounding lands with Briley soils produced no *C. grayoides*.

Voucher specimens: ARKANSAS. Nevada Co.: Ebenezer Cemetery, T12SR20W, section 21, parking area, 3 Aug 1995, *Logan* 95-129 (UCA); T13SR20W, sect. 6, sand barrens, 10 Aug 1995, *Logan* 95-135 (UCA). Ouachita Co.: T12SR18W, sect. 6, sand barrens, 1 Aug 1995, *Logan* 95-122 (UCA); Poison Springs State Forest, T12SR19W, sect. 26, sand barrens, 2 Aug 1995, *Logan* 95-123 (UCA); T12SR18W, sect. 18, sand barrens, 3 Aug 1995, *Logan* 95-128 (UCA); immediately north of Arkansas Oak Natural Area, T12SR20W, sect. 28, sandy clearing in oak-pine forest, 9 Aug 1995, *Logan* 95-133 (UCA); T12SR18W, sect. 16, sand barren, 29 Aug 1995, *Logan* 95-136 (UCA).

DISCUSSION AND CONCLUSIONS

The typical habitat of *C. grayoides* is open barren areas of sandhills where enough slope is present to produce some erosion of the deep, loose sand. The only site where it was found in somewhat compacted, uneroding sand was a cemetery with only a few individuals that did not appear to be thriving. *C. grayoides* appears to require disturbance sufficient to limit competition and to provide open, loose sand for seedling establishment. Such areas are commonly shoulder and side slopes that lack the loamy A horizon re-

ported for the Alaga series (Catlett 1973). Instead, the appearance of the surface soil is more like that described for the white, loose C4 horizon. The most severely disturbed site with *C. grayoides* was on a south and southwest facing slope where the timber had been recently harvested. Here it was thriving, particularly near areas with heavy vehicle traffic.

However, extreme disturbance may be harmful to the species, and, in the long run, timber harvest could result in shrub growth which would diminish the open character of the habitat. The species was never found in shaded situations, and at one site forest encroachment appeared to have limited the population size.

The lack of a completed soil survey for Nevada County prevented a complete survey. When a soil survey for this county is available, it is possible that additional populations of *C. grayoides* will be discovered.

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BRACHIARIA ERUCIFORMIS AND *UROCHLOA BRIZANTHA*
(POACEAE: PANICEAE) NEW TO TEXAS

Brachiaria eruciformis (J.E. Smith) A. Grisebach and *Urochloa brizantha* (C. Hochstetter ex A. Richard) R. Webster, previously unreported for Texas have been found in the Edwards Plateau (McCulloch Co.) and southern Rolling Plains (Runnels Co.) respectively.

Brachiaria eruciformis is native to Africa, the Mediterranean region, and east to India. *Brachiaria eruciformis* has been introduced into Australia (Webster 1987; Simon 1993), South America (Morrone & Zuloaga 1992), Southeast Asia (Lazarides 1980), West Indies (Gould 1979), and the United States (Hitchcock 1951; Steyermark 1963). However, Correll and Johnston (1970), Gould (1975), and Hatch et al. (1990) do not report this species as occurring in Texas. No Texas specimens were located at the following herbaria: ARIZ, BRIT, NMC, NMCR, OKL, and TEX-LL.

Brachiaria eruciformis is a tufted annual with wiry to spreading culms. Plants are 10–60 cm in height. Leaf blades are linear to narrowly lanceolate; 2–15 cm long, and 2–6 mm wide. Inflorescence is 1–8 cm long with 6–12 appressed-erect spicate primary unilateral branches, branches 1–2.5 cm long. Primary branches are minutely pubescent, bearing small closely imbricate spikelets on short pedicels. First glume minute; second glume and lower lemma are of equal length, 1.8–2.0 mm long. Upper lemma is readily deciduous, smooth, shiny, and obtuse.

Voucher specimens: TEXAS. McCulloch Co.: grazed-out wheat field, 7 mi W of Brady, 15 Jun 1992, H. Hanson s.n. (TAES); in wheat stubble on H. Hanson farm, 5 mi NW of Brady on Hwy 283, 23 Jun 1993, H. Hanson s.n. (TAES).

Urochloa brizantha [syn. *Brachiaria brizantha* (A. Richard) O. Stapf], a native of Africa. It has been widely introduced around the tropics as a forage grass in Australia (Webster 1987; Simon 1993), Central America (Pohl 1980), South America (Morrone & Zuloaga 1992), Southeast Asia (Lazarides 1980), the Indian subcontinent (Bor 1960), and the United States (Rotar 1968; Hall 1978). However, Correll and Johnston (1970), Gould (1975), and Hatch et al. (1990) do not report this species as occurring in Texas.

Urochloa brizantha is an erect perennial up to 2 m in height, culms occasionally branching from the middle nodes. The ligule is a short, stiff, ciliate membrane 1.2–2.2 mm long. Leaf blades are lanceolate, 15–35 cm long and 7–18 mm wide. The inflorescence is a panicle of spicate primary unilateral branches, branches 6–12 cm long. The spikelets are 5.0–5.8 mm long and short pedicellate. The first glume is broadly deltoid, second glume and lower lemma are of equal length. The upper floret is 4.3–4.6 mm long, rigid, finely striate or minutely rugulose.

Voucher specimen: TEXAS. Runnels Co.: near Rowena on farm of Mr. Gerngross; plants from seed collected by Ralf Gerngross along Hwy 83 between Ballinger and Paint Rock, 18 Nov 1993, *J. Landers s.n.* (TAES).

We would like to thank Joseph K. Wipff, III and Hugh D. Wilson for their helpful comments in improving the manuscript.—*William E. Fox, III and Stephan L. Hatch, S.M. Tracy Herbarium (TAES), Department of Rangeland Ecology and Management, Texas A&M University, College Station, TX 77843-2126 U.S.A.; and Roger Q. Landers, Jr., Extension Specialist (Ret.), Department of Rangeland Ecology and Management, Texas A&M University, San Angelo, TX 76901-9782.*

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FIRST REPORT OF *WOLFFIELLA LINGULATA*
(LEMNACEAE) IN WESTERN MEXICO

Wolffiella are small, glabrous, thalloid plants that often occur with other species of Lemnaceae. The thallus is flat and thin, appearing two-dimensional, mostly solitary but occasionally with two to several attached. They float freely within the water column of quiet waters, seldom forming large colonies. Daubs (1965) reports that flowering is rarely observed in *W. lingulata*; however, Landolt (1986), in his comprehensive monograph of Lemnaceae, reports that *W. lingulata* is frequently observed flowering or fruiting.

Wolffiella lingulata (Hegelm.) Hegelm. usually floats in the water column just below the surface. The thallus is broad, oblong to ligulate in shape, dorsoventrally flattened, and channeled. The surface is usually prominently punctate with brown pigment cells in the epidermis. Two to four thalli often remain connected and are recurved, thus appearing like a segment of a curved band (Correll & Correll 1975). The plant is distributed in the tropical and warm temperate areas of Meso-America, Mexico, southern United States, and as far south as Argentina and Uruguay (Daubs 1965). McVaugh (1993) excluded the genus *Wolffiella* from Flora Novo-Galiciana but mentioned its probable presence there based upon its occurrence in nearby extra-territorial areas. The area treated in Flora Novo-Galiciana is historically known as Nueva Galicia and includes the states of Jalisco, Colima, and adjacent portions of the states of Nayarit, Durango, Zacatecas, Aguascalientes, Guanajuato, and Michoacán. Daubs (1965) reported *W. lingulata* in Lakes Pátzcuaro and Jiquílpan, both located in a part of Michoacán excluded from the flora.

Recent field collecting yielded specimens of *Wolffiella lingulata* from four different locations in Jalisco, thus the genus may now be considered as part of the flora of Nueva Galicia. In the following list of exsiccata, geographical coordinates and elevations were taken with a global positioning system. All CES numbered specimens were collected under the supervision of W. C. Holmes by the aquatic botany class of the Chapala Ecology Station (CES). The Chapala Ecology Station is operated by the Universidad Autonoma de Guadalajara and Baylor University. Duplicate specimens will be distributed to IBE, MIA, NLU, GUADA, and VDB at a later date.

Voucher specimens: MEXICO. Jalisco: Lago de Chapala, ca. 1 km east of Mezcala, N 20° 20' 02.0" W 103° 03' 04.2", 1504 m, 22 Jun 1995, Holmes 7802 (BAYLU); Chapala, between boat launch and yacht club, marshy shoreline of Lago de Chapala, N 20° 17' 16.4" W 103° 11' 35.9", 1496 m, 9 Jun 1995, CES 66, CES 72, and CES 73 (all BAYLU); Guadalajara, aqueduct under Hwy 23, N 20° 39' 29.2" W 103° 15' 50.5", 1470 m, 16 Jun

1995, CES 112 (BAYLU); Lago del Ahogado, N 20° 39' 29.2" W 103° 16' 03.2", 1536 m, 12 Jun 1995, CES 84A (BAYLU).

Wolffiella was abundant at all collection stations and was associated with large floating mats of *Eichhornia crassipes* (Mart.) Solms. (Pontederiaceae), being found among the roots and lower portions of the floats. It was discovered by submersing the *Eichhornia* into the water, thus allowing the *Wolffiella* to float to the surface. Occasionally associated plants included *Spirodela polyrhiza* (L.) Schleid., and *Lemna gibba* L. (both Lemnaceae), *Sagittaria longiloba* Engelm. (Alismataceae), *Myriophyllum aquaticum* (Vell.) Verde. (Haloragaceae), and *Berula* sp. (Umbelliferae). All *Wolffiella* specimens collected were in the vegetative condition.

The widespread occurrence of *W. lingulata* seems to indicate that the plant is not a recent introduction but only overlooked. That it has only now been discovered may be related to its presence at the end of the dry season, generally an unfavorable time for collecting in the Lago de Chapala basin. Coupled with this is its close association with *Eichhornia crassipes*, a plant which may provide *Wolffiella* with aspects of a suitable environment (protection from waves and intense sunlight) not normally present at this time. *Eichhornia crassipes* is a weedy plant that is generally not collected; however, this, and its ability to interfere with water use, makes it an important plant for aquatic botany classes, hence the discovery of *Wolffiella*.

We wish to thank Sidney McDaniel of the Institute for Botanical Exploration (IBE) for verifying our determinations.—*T.L. Morgan, J.R. Stevens, and W.C. Holmes, Department of Biology, Baylor University, Waco, TX 76798-7388, U.S.A.*

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KRAPOVICKASIA PHYSALOIDES (MALVACEAE) AND
LACTUCA INTYBACEA (ASTERACEAE) NEW
 TO TEXAS AND THE UNITED STATES

We herein report the above two species new to the United States so that their names may be readily available to those individuals working on the Flora of North America project.

Fryxell (1978) segregated four species of *Sida* including *Sida physaloides* Presl into *Krapovickasia*. Until now *K. physaloides* (Presl) Fryxell has been reported in oak forest only from the Mexican states of Tamaulipas, Nuevo Leon, and San Luis Potosí (Fryxell 1988). In June of 1995, the second author collected this species in Texas.

Voucher specimen. TEXAS. Karnes Co.: sandy oak woods on the Adanal Ranch off of highway 119, 5 mi SE of Gillett, 14 Jun 1995, *Muschalek* 10 (SBSC, TEX).

He found the plants only on sandy soil under post oak (*Quercus stellata* Wang.) trees and noted that they were totally absent from the adjacent mesquite dominated clay soils. He estimated that at least 2,000 plants were growing on 300 acres of sandy soils. In late July of 1995, the flowers opened at about 4:00 p.m. and closed at approximately 6:00 p.m. The fresh flowers were white but faded to a pale rose color when they closed (Fig. 1). Other associated plants included: *Diospyros texana* Scheele, *Opuntia leptocaulis* DC, *Opuntia lindheimeri* Engelm, *Mahonia trifoliolata* (Moric.) Fedde, *Dyschoriste linearis* (T.&G.) O. Ktze., *Coreopsis nuecensis* Heller, *Sabatia campestris* Nutt., *Hypericum drummondii* (Grev. & Hook.) T.&G., *Sida lindheimeri* Engelm. & Gray, *Sida ciliaris* L., *Sida rhombifolia* L., *Galactia marginalis* Benth., *Zornia gemella* Vogel, *Chamaecrista fasciculata* (Michx.) Greene, *Cynanchum barbigerrum* (Scheele) Shinnars, *Polygala incarnata* L., and *Aster sericeus* Vent. Dr. Fryxell (TEX) kindly verified our identification.

Lactuca intybacea Jacq. is a weedy tropical plant occurring from Sinaloa and San Luis Potosí southward through Mexico, Central America, and the West Indies to northern South America (McVaugh 1984). In 1993 the first author collected an unknown composite in Starr County, Texas (Fig. 2). He identified it as a *Lactuca* and later as the above species by comparison with collections at TEX.

Voucher specimen: TEXAS: Starr Co.: small population on dry caliche slopes overlooking the broad floodplain of the Rio Grande River along hwy 83 near the high water tower E of Rio Grande City, 16 Mar 1993, *Brown* 16813 (SBSC, TEX).

The following partial list of species on these caliche slopes emphasizes the essentially Mexican nature of the vegetation at this site: *Cordia boissieri* A. DC., *Helietta parvifolia* (Gray) Benth., *Mortonia greggii* Gray, *Aloysia*



FIG. 1. *Krapovickasia physaloides*. Flower and leaves from the Adanal Ranch population.

macrostachya (Torrey) Moldenke, *Gochnatia hypoleuca* (DC.) Gray, *Lippia graveolens* H.B.K., *Waltheria indica* L., *Turnera diffusa* Willd., *Cenchrus ciliaris* L., *Meximalva filipes* (Gray) Fryxell, *Hibiscus martianus* Zucc., *Cevallia sinuata* Lag., *Nama undulatum* H.B.K., *Nama parvifolium* (Torrey) Greenm., *Nama jamaicense* L., *Acalypha hederacea* Torrey, *Nerisyrenia camporum* (Gray) Greene, *Croton incanus* H.B.K., and *Senna baubinioides* (Gray) Irwin & Barneby.



FIG. 2. *Lactuca intybacea*. Close up photograph of the collection, *Brown 16813*, from the Spring Branch Science Center Herbarium (SBSC). Bar equals 2 cm.

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NEW COUNTY RECORDS FOR *BELLARDIA TRIXAGO*
(SCROPHULARIACEAE) IN TEXAS

Bellardia trixago (L.) All. is considered native to the Mediterranean region where it grows in disturbed areas, sandy soils, and woods (Weatherwax 1993; Polunin 1969). Within the United States, *B. trixago* has been reported in California and Texas. Weatherwax (1993) gives the California distribution as disturbed places of less than 200 m elevation in the San Francisco Bay Area, the Outer North Coast Range, and the Central Coast. In Texas, the first report of the plant was made by Lipscomb and Ajilvsgi (1982) who cited the plant as occurring in Navarro County within the Blackland Prairies vegetational region. The species was conspicuous in open fields and pastures, but was "more abundant along roadsides associated with lighter textured soils in the uplands." Lipscomb and Ajilvsgi, however, were unable to find specimens in Freestone County and other adjacent areas. Hatch et al. (1990), apparently based upon the Lipscomb and Ajilvsgi (1982) report, list the distribution to be within the Blackland Prairies.

Recent collections document the expansion of the known distribution of *Bellardia trixago* to include other counties of the Blackland Prairies as well as areas of the Gulf Prairies and Marshes, Post Oak Savannah, and Pineywoods vegetational regions (Fig. 1). This species was primarily found in sandy soils along roadsides and is often associated and sometimes confused with *Castilleja indivisa* Engelm. (Scrophulariaceae).

We speculate the spread of *Bellardia trixago* is facilitated by the harvest and dissemination of wildflower seeds by the Texas Department of Transportation.

Specimens examined: **TEXAS.** Anderson Co.: jct of Hwy 287 and FM 59, 28 Apr 1995, *Singhurst* 3266 & *Do* (BAYLU). Brazos Co.: W side of roadside of W Loop 2818 at jct. of 2818 and Carson Street, 20 May 1983, *Ajilvsgi* 8390 (TAMU). Colorado Co.: Hwy 71, ca. 6 mi NW of Columbus, near FM 1890, 16 Apr 1993, *Nesom* 7576 & *Watson* (BRIT). Freestone Co.: vacant lot near jct of FM 80 and TX Hwy 164, Donie, 24 Apr 1994, *Holmes* 7027 (BAYLU); outside of entrance to Fairfield Lake State Recreational Area, 6 mi NE of Fairfield, 21 Apr 1995, *Do* 482 (BAYLU). Harris Co.: Hwy 290, Houston, 25 Apr 1991, *Edwards* 31 (BAYLU). Henderson Co.: 3.8 mi NW of Eustace on Hwy 175, N side, 5 May 1995, *Singhurst* 3262 (BAYLU). Hill Co.: Hwy 31 E of Hubbard, 1/4 mi W of Hill/Navarro Co. line, 24 Apr 1995, *Tabor* 141 (BAYLU). Kaufman Co.: 2.6 mi S of jct of Hwy 175 and FM 274, W side of 274, just W of Cedar Creek Reservoir, 5 May 1995, *Singhurst* 3263 (BAYLU). Leon Co.: 1/2 mi past Leon/Freestone Co. line, 22 Apr 1995, *Tabor* 143 (BAYLU); N side of Hwy 7, 3.2 mi E of Robertson/Leon Co. line, 5 May 1995, *Singhurst* 3264 (BAYLU); 1/2 mi W of Leona, TX on FM 977 at jct with I-45, 1 May 1992, *Nixon* 17700 (ASTC, BRIT). Liberty Co.: Liberty, behind Lynnwood Ave., next to drainage ditch, 15 Apr 1995, *Post* 93 (BAYLU). Limestone Co.: 12.6 mi E of Groesbeck on TX Hwy 164, just E of Big Creek, 23 Apr 1994, *Holmes* 7038 (BAYLU). Milam Co.: 7

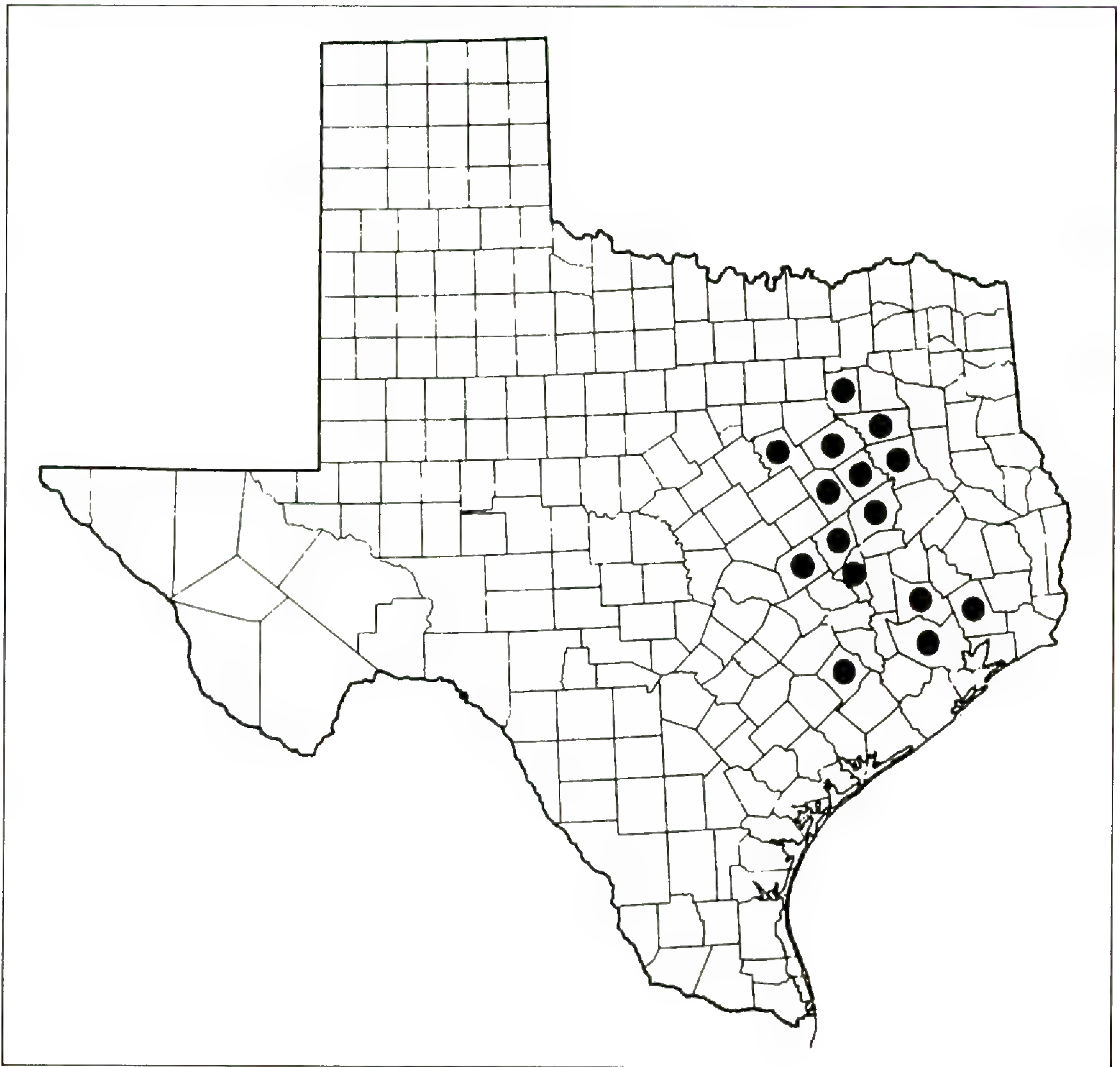


FIG. 1. Documented distribution of *Bellardia trixago* in Texas.

mi S of Milam / Falls Co. line on FM 2027, 22 Apr 1995, *Do* 450 (BAYLU). **Montgomery Co.:** near Conroe, along roadside of I-45, near exit #89, 11 Apr 1995, *Purswell* 275 (BAYLU). **Navarro Co.:** 40 paces E of Hill / Navarro Co. line, 24 Apr 1995, *Tabor* 142 (BAYLU); jct of Hwy 75 and FM 415 in Streetman, Texas, ca. 2.1 mi E on FM 415, S side of FM 415, 30 May 1995, *Singhurst* 3328. **Robertson Co.:** FM 937; 80 paces past county line S of Lake Limestone, 22 Apr 1995, *Tabor* 144 (BAYLU).

We wish to thank the curators of the herbaria that made this study possible and the Texas Parks and Wildlife Department for partial financial support and permission to study at Fairfield Lake State Recreational Area. —L.H. *Do* and W.C. *Holmes*, Department of Biology, Baylor University, Waco, TX 76798-7388, U.S.A. and J.R. *Singhurst*, Wildlife Division, Texas Parks and Wildlife Department, Mexia, TX 76667, U.S.A.

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BOOK REVIEWS

REICHMAN, O.J. (text), STEVE MULLIGAN (photographs). 1995. **Living Landscapes of Kansas**. (ISBN 0-7006-0727-7, hbk). University Press of Kansas, 2501 West 15th Street, Lawrence, KS 66049-3904, \$29.95, 154 pp, 122 color photos, 8 b&w photos.

Living Landscapes of Kansas portrays the scenic beauty of prairie vistas, rolling flint hills, eastern deciduous forest, streams and valleys, botanical splendors, and special geologic formations in photographic color images. Steve Mulligan's photography combines the mastery of film and camera with the precise moment and mood of time and place. He has an eye for spectacular and stunning landscapes for everyone to enjoy such as the Cheyenne Bottoms against the background of a kaleidoscope of colors created by a brilliant sunset. Indeed, if one opens the pages of this book and scans the beautiful photographs alone, the reader would be hardpressed to recognize the source as Kansas, except for more familiar sites like Castle Rock in western Kansas. The layout of the book ranges from full page photographs to a combination of text and two photographs of various sizes per page. There are wide margins and text spacing that facilitates perusal of the book. The text is nontechnical and Reichman's engaging style makes this enjoyable reading for the general public.

Earth, fire, wind and water have played a major role in shaping the modern landscapes of Kansas. This section of the book deals with forces of nature that have created geological formations. The photographs in this section are best illustrated by the full page image of Cedar Bluffs in Trego County. The natural lighting and rich color tones of these photographs accentuates the natural beauty of these areas.

Natural regions of Kansas are organized based on eleven physiographic provinces as illustrated in a color-coded map of the state. These provinces are the Ozark Plateau, Cherokee Lowlands, Osage Cuestas, Chautauqua Hills, Flint Hills, Wellington-McPherson Lowlands, Red Hills, Arkansas River Lowlands, Smoky Hills, High Plains, and Glaciated Region. There are some special scenes here in this section of the book that deserve special comment. The colorful glacial boulders with pinkish hues that contrast with the greenish crustose lichens that cover their surface define the edge of the Flint Hills in Wabaunsee County in central Kansas. The brick-red buttes of the Red Hills in southern Kansas, Barber County, represent one of the most striking landscapes in Kansas. The Flint Hills represent a large number of the photographs in this book, with special emphasis on the most important tallgrass prairie remnant left in North America, the Konza Prairie Research Natural Area in Riley County near Manhattan.

Geologic oddities is a section of the book devoted to special geologic formations such as Castle Rock, St. Jacob's Well, Elephant Rock, Monument Rock, Rock Town in Russell County and the famous Mushroom Rocks in Ellsworth County. There is an unfortunate error on page 39 where the caption has Castle Rock in Trego County instead of its actual location in Gove County. Some of these photographic images such as Sunset at Keyhole Arch and Dawn Over Castle Rock and Sunset behind Castle Rock in Gove County will render the viewer spellbound by the incredible beauty of the sun, shadows and rock formations. The price of the book is worth these series of pictures alone.

Vegetation comprises the major theme of the book (80 pages) divided into the prairies, forests and woodlands, and water and wetlands. The passing of the seasons are highlighted by colorful prairie forbs such as butterfly milkweed, springtime and fall colors of prairie grasses, and selected trees and flowering shrubs scenes. There are some beautiful images of

the brilliant fall colors of reds and yellows of the broadleaf deciduous trees. Winter snow scenes remind the reader of the diverse climatic changes that can occur on the Kansas plains. As a botanist I would have liked to have seen more diversity of colorful prairie forbs and a few showy sunflowers since it is the state flower.

Water and wetlands is the section of the book that grabs the readers visual attention and will not let go. There are black and white photographs scattered through this section that give a special touch to aquatic habitats. Sunsets always have a special photographic appeal. There are several sunsets that are especially noteworthy, Big Salt Marsh Quivira National Wildlife Refuge, Cheyenne Bottoms, Pomona Lake, and Clinton Lake. Streams also produce special affects as water flows over rocks and creates waterfalls of various heights as seen at Pillsbury Crossing, Deep Creek, in Wabaunsee County. Caves are formed from the action of water dissolving limestone over time. Entrances of several caves are illustrated but the most eye-catching picture is a shot taken from inside Pope Cave, in Comanche County, showing the entrance and the images of the trees and shrubs outside the cave reflected on a pool of water inside on the cave floor.

The last section of the book involves the processes that shape landscapes and the influence of plants and animals on landscapes in Kansas. Weather patterns of temperature, rainfall, hail, tornadoes, and snow help shape landscapes. This is pictorially represented by Monument Rocks in Gove County, cumulus clouds over the Flint Hills in Chase County, winter sunrise in Sherman County, and fog along the Smoky Hill River to mention some examples. Lichens are pioneer organisms on barren soil and rocks and their brilliant red, green and yellow colors create striking photographic images on bare rock surfaces. Every person who wishes to experience the beauty and diversity of Kansas landscapes should have this book on their bookshelf. —*Harold W. Keller, Research Associate, BRIT.*

NEUBERT, H., W. NOWOTNY, and K. BAUMANN. 1995. **Die Myxomyceten Deutschlands und des angrenzenden Alpenraumes unter besonderer Beruchachtung Österreichs, Band 2, Physarales.** (ISBN 3-929822-01-6, hbk). Karlheinz Baumann Verlag, Gomaringen, 190 German Marks. 368 pp, 208 color photos, 163 drawings, 108 scanning electron micrographs.

English translation of the title: **The Myxomycetes of Germany and its bordering Alpine Areas, with special attention to Austria. Volume 2, Physarales.**

This is Volume 2 (order Physarales) of a three volume series. Volume 3 (order Stemonitales) will follow in about two years. The volumes may be purchased separately. The acquisition of a volume does not obligate one to purchase other volumes but some literature citations in Volume 2 are found only in Volume 1.

The introduction gives an overview of the contents of the book and general information about the structure of fruiting bodies in the Physarales and their occurrence in nature. The authors estimate that the order Physarales has 400 species and varieties and of these 167 are recorded from Germany. These are described in detail and are well illustrated. Important characteristics are given for an additional 233 species and varieties.

There is a glossary of 28 general terms that, for the most part, apply to fungi, not to

Myxomycetes. Volume one contains 45 defined terms that apply to the Myxomycetes. There is a section that lists the scientific and German names of the substratum, usually from the bark of trees. A brief discussion of nomenclature of the Myxomycetes considers these organisms aligned with the fungi, retaining the proper designated endings prescribed by the International Code of Botanical Nomenclature. There is an interesting section about the history of the Myxomycetes as this relates to the number of new species known over time. The author's estimate that there are about 1,000 species and varieties known today. Unfortunately, there is nothing to indicate how that number was determined. In 1969 54% of the species were known, and in 1980, 76%. Recent myxomycetologists are listed with the percentage of new species described by them. Nannenga-Bremekamp at 20% far surpasses all of the other myxomycete taxonomists.

The section on economic aspects of Myxomycetes describes the migratory plasmodium and subsequent development of fruiting bodies of *Diachea leucopodia* that covered the stems, leaves and fruits of living plants, for example, on lettuce and strawberries grown in beds. *Physarum gyrosum* and *Physarum didermoides* are examples of Myxomycetes that colonized a bed of lettuce. The authors note the yellow plasmodium of *Fuligo septica* growing on bark mulch. Apparently, this growth created a panic that required the removal of the bark mulch to a dump. *Badhamia foliicola* was found growing on living lawn grass but attempts to remove the myxomycete were unsuccessful, even after cutting out sections of sod and wiping blades of grass.

A brief topical section under species communities notes that certain species sporulate together in close association on the same substratum. These ecological associations are recorded in the text. Distribution is discussed in general terms but distribution charts are not included that map the occurrence of Myxomycetes. The authors note, and rightly so, that distribution charts have limited value, and more attention should be given to ecological conditions when collecting specimens.

A section under the topical heading of people working on Myxomycetes in the area concerned and in adjacent countries lists over 160 alphabetized names of European students of the Myxomycetes, dating back to the middle 1700s. The year of birth and death are given for each deceased person and year of birth for persons still alive. This provides a quick frame of reference for the time period when each of these persons lived and studied Myxomycetes. A section on etymology lists the origin of 30 genera and over 280 species names.

There are dichotomous keys to the families and to genera. *Diachea* is included in the Didymiaceae in accordance with more modern treatments instead of in the Stemonitales. There are both dichotomous and synoptic keys to the species of the genus *Diderma*, *Didymium*, *Badhamia*, and *Physarum*.

Some of the photographs of colored plates were taken from Jacob Sturm's "Flora of Germany" published in 1813, 1814 and 1816 and illustrate *Diderma floriforme*, *Physarum contextum*, *Didymium iridis*, *Craterium leucocephalum*, *Craterium minutum*, *Physarum viride* var. *aurantium*, and *Physarum viride* var. *viride*. These habit illustrations are enough of a likeness of the species in question that, in most cases, it can be picture keyed. This is quite remarkable when one considers that these paintings were made in the early 1800s.

The color photographs of the fruiting body habits are the highest quality I have ever seen. Some of the colored photographs are of fruiting bodies in an immature and freshly matured state. This is true of *Badhamia utricularis*, *Diderma floriforme*, *Fuligo septica* var. *flava*, and *Leocarpus fragilis*. The calcareous bearing Physarales have many species with bright colorful plasmodial stages and fruiting bodies. Volume 2 has color photographs

only of the fruiting body stages not the plamodial stage. The illustrations of color photographs and line drawings are conveniently included in the text on the same page as the species description. The SEM's are included as a group at the back of the book along with a series of 18 plates of spore illustrations hand drawn in black and white that show surface ornamentation. The quality of the hand drawn spores is excellent but the SEM's in many cases were taken at too low a magnification and details are obscured by excessive charging. Some of the structures are shriveled beyond recognition and combined with the poor preparation techniques are not very instructive. The overall quality of the SEMs in Volume 2 does not match the quality in Volume 1. The photographs and line drawing illustrations have a voucher specimen number cited as the source of the illustration. The authors are to be commended for following this practice.

The author's classification system recognizes three families in the order Physarales: the Didymiaceae, Elaeomyxaceae, and Physaraceae. There are seven genera in the Didymiaceae: *Diachea* (formerly classified with the Stemonitaceae), *Diderma*, *Didymium*, *Lepidoderma*, *Mucilago*, *Physarina*, and *Trabrooksia*. There are a number of nivicolous species (myxomycetes that grow and sporulate in association with snowbanks) in the genera *Diderma*, *Didymium* and *Lepidoderma* that are described and illustrated with beautiful habit photographs in color. There are nine genera recognized in the Physaraceae: *Badhamia*, *Craterium*, *Erionema*, *Fuligo*, *Leocarpus*, *Physarella*, *Physarum*, *Protophysarum* and *Wilkommlangea*.

Most of the references cited in the text of Volume 2 are listed in Volume 1 (approximately 790). It appears that the 116 references cited in Volume 2 are new references cited only there. Even though Volume 2 can be purchased as a separate volume the lack of a complete bibliography will limit its effective use.

This volume contains some of the best color habit photographs of physaraceous Myxomycetes I have ever seen. Some species are illustrated in color for the first time. Any serious student of the Myxomycetes will want to have this volume on their bookshelf.
—Harold W. Keller, Research Associate, BRIT.

SPOERKE, DAVID G. and BARRY H. RUMACK, eds. 1994. **Handbook of Mushroom Poisoning: Diagnosis and Treatment.** (ISBN 0-8493-0194-7, hbk). CRC Press, Inc., 2000 Corporate Blvd., N.W., Boca Raton, FL 33431, \$127.95, 456 pp, 66 color photos.

This book is organized into 26 chapters written by 20 contributors. Each chapter is self-contained with a separate bibliography. General introduction and identification comes first, then toxicology and finally mushroom odors, differentiation of *Lactarius* by latex and color changes, a glossary of terms and bibliography. There are similarities between this book and Rumack and Salzman's *Mushroom Poisoning: Diagnosis and Treatment* published in 1978 by CRC Press. Indeed, the flyer refers to the Second Edition but the title of the book and inside cover page makes no mention of a Second Edition. There are 66 colored plates that are not very informative and of inferior quality. Plate 48 of *Amanita muscaria* is out of focus.

The first chapter is an "Introduction to Identification and Toxicology" by David Spoerke. This chapter and the second chapter, "Amateur Opportunity," by Marilyn Shaw, give more of a nontechnical approach to the subject matter. Shaw emphasizes the role of knowledgeable amateurs in mycology and does so with an engaging writing style punctuated with humorous stories and interesting anecdotes. From the standpoint of pure enjoyment of

reading this chapter wins hands down. There is a treasure trove of information in this chapter, including a table of 70 mushroom clubs in the United States with complete addresses. The history behind the formation of the North American Mycological Association (NAMA) and its role in amateur mycology is discussed. This is the most informative account to date on the role of an amateur as a mushroom consultant to poison centers. Golden nuggets of information about mushroom ingestions, antidotes, handling telephone calls concerning mushrooms, case histories and fact-finding, analysis of facts, positive identification and follow-up are found here and nowhere else. Shaw is an excellent example herself of a volunteer resource that through years of experience has developed a useful protocol for dealing with mushroom poisonings and poison centers.

The identification of mushrooms in general is covered in chapters by the late Alexander Smith (poisonous mushrooms their habitats and geographic distribution), Orson Miller (mushroom orders and families), the late George Grimes (principles of mushroom identification), and Linnea Gillman (identification of common poisonous mushrooms). There is some overlap in the chapters by Smith, Grimes and Miller, that could have been avoided with proper editorial oversight. Some of the reproductions look as if they are poorly xeroxed copies of photographs such as Figure 2 on page 100 and Figure 16 on pages 112 and 113 that is reduced to such a small size it is barely readable. The chapter on mushroom field tests, by Spoerke provides chemical techniques for the identification of macro- and microscopic approaches to color reactions.

The following chapters concentrate on mushroom toxicity and poisoning with "Symptomatic Diagnosis and Treatment of Mushroom Poisoning," by Rumack that gives the symptoms as a clue to identify the mushroom species as well as guiding treatment. Chilton's chapter, "The Chemistry and Mode of Action of Mushroom Toxins," is a comprehensive review of this subject with extensive up-to-date references (over 400). The ten chapters that follow deal with specific toxins that covers their chemistry, symptomatology, diagnosis, and treatment: amatoxins; orellanine mushrooms; ibotenic acid/muscimol-containing mushrooms; monomethylhydrazine-containing mushrooms; muscarine-containing mushrooms; coprine-containing mushrooms; psilocybin-containing mushrooms; *Chlorophyllum molybdites* (the green-spored mushroom); boletes and their toxins; gastrointestinal irritant mushrooms. The chapter on the green-spored mushroom should be of special interest to poison centers and physicians in Texas since it is the most common lawn mushroom throughout the summer months and the source of numerous poisonings, at least in the Dallas-Fort Worth area. The concluding chapters cover diverse topics, including carcinogenicity; hypersensitivity; and miscellaneous mushroom toxins.

The point size of the print appears small and difficult to read but this is a tradeoff against more pages and a more costly book. Even so, the cost of this book will put it beyond the reach of most amateur mycologists. It will be of more value to libraries, poison centers, and physicians as a reference source.—Harold W. Keller, Research Associate, BRIT.

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TAXONOMIC STATUS OF *HYMENOCALLIS CHOCTAWENSIS* AND *HYMENOCALLIS PUNTAGORDENSIS* (AMARYLLIDACEAE)

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ABSTRACT

Two poorly known species of spider-lilies described by Hamilton Traub, *Hymenocallis choctawensis* and *Hymenocallis puntagordensis*, are shown to be worthy of recognition. Distinguishing characteristics and distributions are presented. Somatic chromosome numbers and, for the first time, karyotypes of these species are presented. A short key is provided to help distinguish *Hymenocallis choctawensis* from taxa with which it is likely to be confused.

KEY WORDS: *Hymenocallis*, Florida, distributions, karyotypes

RESUMEN

Se demuestra que dos especies poco conocidas de himenocálide ("lirio araña") descritas por Hamilton Traub, *Hymenocallis choctawensis* y *Hymenocallis puntagordensis*, son dignas de reconocimiento. Se presentan las características distintivas y las distribuciones. Se dan los números somáticos de cromosomas, y, por primera vez, han sido preparados los cariotipos de estas especies. Se proporciona una clave corta para ayudar a distinguir *Hymenocallis choctawensis* de los taxa con los que puede confundirse fácilmente.

PALABRAS CLAVE: *Hymenocallis*, Florida, distribuciones, cariotipos

The species of *Hymenocallis* native to the United States have perplexed those who have tried to identify either herbarium specimens or plants in the field. The puzzlement, at least in part, is due to the lack of a comprehensive modern treatment that deals with the myriad of published spider-lily names and establishes distinctive species concepts. Godfrey and Wooten (1979) emphasized the need for quality herbarium vouchers of native populations throughout the southeastern United States and for published information about the characteristics of the plants in the wild. Such information would provide the basis for a treatment emphasizing field characteristics and distinctive features recognizable on herbarium specimens.

Smith and Flory (1990) and Smith and Darst (1994) presented studies on selected species of *Hymenocallis* that were based on field, herbarium, and cytological data. This approach was successful in defining the species under study and holds promise for clarifying the taxonomy of many of the southeastern *Hymenocallis* species.

Traub (1962) published a key to the species of *Hymenocallis* but unfortunately provided little nomenclatural background concerning his chosen names or information about the plants as they would be found growing in the wild. His treatment did not deal with a number of published names such as *Hymenocallis crassifolia* Herb. and *H. liriosme* (Raf.) Shinnery, and we can only conclude that he considered them synonyms or invalid names. However, Traub did have a large greenhouse collection of spider-lilies, and he displayed a remarkable ability to recognize different species of *Hymenocallis*.

Traub's understanding of native southeastern spider-lilies was considerably enhanced by the field endeavors of Mary G. Henry (Henry 1950; Traub 1962). Driven by her devoted chauffeur, Ernest Perks, in a Cadillac outfitted with oversized tires for field travel and redesigned for collecting plants and recording field observations, Mrs. Henry acquired an extensive bulb collection. She often prepared herbarium vouchers from the populations from which she acquired a bulb sample. Mrs. Henry sent Traub bulbs of each collection so that he could cultivate them, bring them into flower, and view the specimens firsthand. When Traub recognized a distinctiveness of form in some of these collections, he described new species. Traub (1962) published five new species of *Hymenocallis* based on Mary G. Henry collections. Traub also relied on Walter S. Flory and his students at the Blandy Experimental Farm of the University of Virginia for cytological information about his bulb collections.

Hymenocallis choctawensis Traub

Hymenocallis choctawensis is one of the species that Traub (1962) described from a collection made by Mrs. Henry. An investigation has led us to conclude firmly that *Hymenocallis choctawensis* is a dominant ground cover species along river systems of the Florida panhandle from the Apalachicola River westward to southeastern Mississippi.

In 1984 the authors made pressed and living collections of a *Hymenocallis* along a tributary of the Choctawhatchee River in Walton County, Florida. This population appeared most similar to specimens in the Florida State University herbarium identified as *H. caroliniana* (L.) Herb. *Hymenocallis caroliniana* was reported to have chromosome numbers of $2n=52$ or 54 (Flory 1975, 1976), so we expected that we would determine these numbers from our collection. Instead, the first author established that the somatic

number of our collection was $2n=44$, and the karyotype exhibited 36 two-armed and 8 telocentric chromosomes (Fig. 1). The identity of this collection with what had been called *H. caroliniana* now seemed remote because of this difference in chromosome number. Within the genus, the number $2n=44$ had also been reported for *Hymenocallis coronaria* (J. Le Conte) Kunth, but collections cytologically examined by Schmidhauser (1954) and Joye and Smith (1993) revealed 32 two-armed and 12 telocentric chromosomes in this species. Our collection thus appeared to differ from all other known species of *Hymenocallis*.

In examining names used for *Hymenocallis* in the western Florida panhandle, we discovered that Traub had proposed *H. choctawensis* for a Mary G. Henry collection. Mrs. Henry's field diaries, made available to the authors by her daughter, Josephine deN. Henry, revealed that the type bulb collection was made along a tributary of the Choctawhatchee River in Walton County, very near our collection. Our specimens were similar morphologically to the type of *H. choctawensis* at MO: most notably, our specimens and the type possessed oblanceolate leaves, rhizomatous bulbs, long-spreading perianth segments and triangular bracts that are not long-tapering.

We concluded that our collection, as well as many of the specimens filed as *H. caroliniana* at FSU, were specimens of *H. choctawensis*. We made field trips to a number of sites where "*H. caroliniana*" had been collected and gathered bulbs and vouchers. Angus Gholson of Chattahoochee, Florida, also sent bulbs. Eventually we determined the chromosome number and karyotype of several of these populations (Table 1). It was gratifying to see the number $2n=44$ repeatedly from collections that we had identified as *H. choctawensis* on morphological grounds. Based on comparisons of arm measurements from figures prepared from several different collections, we observed uniformity in both the two-armed and telocentric chromosome types.

The measurements below were taken from pressed, dried herbarium specimens with the exceptions of the seed and fruit dimensions, which were measured on fresh specimens. The pressed specimens that were studied were either received on loan or examined during herbarium visits, or were made by the authors. All qualitative information came from observations of plants in the field or cultivated in the greenhouse.

Hymenocallis choctawensis Traub, Plant Life 18:70. 1962. (Fig. 2). TYPE: UNITED STATES. FLORIDA: Walton Co.: from bulbs collected by Mrs. Mary G. Henry, specimen Traub 263 *a + b* (HOLOTYPE: MO! ex TRA).

Bulb rhizomatous, ovoid to subglobose, $3-6 \times 2-5$ cm, neck 2–8 cm, basal plate 1.5–5 cm; tunica gray-brown. *Leaves* 5–9, arching upward to suberect, shiny green, oblanceolate, channeled proximally, blade gradually tapering towards the base, $3.5-7.5(-8.5)$ dm $\times$ 2.5–6 cm, coriaceous, apex acute. *Scape* 3.5–6.2 dm, two-edged, glaucous; 2 or 3 scape bracts enclosing



FIG. 1. Chromosomes of *Hymenocallis choctawensis*, $2n=44$. A. Mitotic metaphase, *Smith & Garland 1432*. B. Karyotype, 36 two-armed chromosomes, 8 telocentrics. The scale equals 10 micrometers.

the buds, 3–4.5(–6) cm $\times$ 15–20 mm; each flower with a subtending bracteole, 2.8–3.7 $\times$ 10–15 mm. *Flowers* 2–8(–12), opening sequentially, highly fragrant; perianth segments slightly ascending to spreading, white, tinged green on keel and at base, 8–12 cm $\times$ 5–9 mm; perianth tube green, 7–11 cm; staminal cup white with small yellow-green eye, funnelform, gradually spreading, shortly tubulose below, 2.5–4 $\times$ 4–5 cm; margin irregularly bi- or tridentate, projections not prominent between the free filaments; free filaments suberect, inserted on a depression, white, 2.5–4 cm, anthers 1.5–2.5 cm, pollen golden; style green in distal half, fading into white proximally, 13–18 cm; ovary ovoid, 10–15 $\times$ 5–10 mm; ovules 1–3 per locule. *Fruit* broadly trigonous to subglobose, 3–4 $\times$ 3 cm. *Seeds* obovoid to elongated, 2–3(–4) $\times$ 1.4–2.3 cm. Somatic chromosome number $2n=44$.

TABLE 1. Chromosome number determinations in *Hymenocallis choctawensis*. *All populations are 2*n*=44 with 36 two-armed chromosomes and 8 telocentric chromosomes.

Collection	Site	2 <i>n</i>
<i>Smith & Garland 1432</i>	N of Red Bay, Walton Co., FL	44(36 + 8T)*
<i>Smith & Anderson 1454</i>	Montgomery Slough, Franklin Co., FL	44
<i>Smith & Anderson 1455</i>	Ft. Gadsden State Park, Franklin Co., FL	44
<i>Smith 1641</i>	Chipola River floodplain, SR-20, Calhoun Co., FL	44
<i>Smith 1642</i>	Apalachicola River floodplain, SR-20, Calhoun Co., FL	44
<i>Gholson 10923</i>	Apalachicola River at Flat Creek, Gadsden Co., FL	44
<i>Gholson & Braxton s.n.</i>	Chipola River N of Marianna, Jackson Co., FL	44
<i>Gordon s.n.</i>	Pascagoula River, George Co., MS	44

Hymenocallis choctawensis Traub, the Florida panhandle spider-lily, is distributed westward from the Apalachicola River and its tributaries to the lower Pascagoula River in southern Mississippi. It extends northward into southern Alabama and southwestern Georgia (Fig. 3). Flowering time, as observed and documented from herbarium sheets, occurs from spring to early summer. Distinguishing characteristics are rhizomatous bulbs, large, oblanceolate, shiny green leaves, and showy inflorescences. The long, white perianth segments that spread from the base of the funnellform staminal cup at right angles to the floral axis are especially distinctive characteristics.

The rhizomes developing from the bulbs are tubular propagators arising horizontally from the upper region of the basal plate. Dense colonial stands form as a result of vigorous rhizome production. The presence or absence of these structures have been reported previously by Small (1933), Sealy (1954), and Herndon (1987).

Hymenocallis choctawensis is found as the dominant ground cover on the banks of alluvial, spring-run, and blackwater streams, and in the floodplain forests and floodplain swamps beyond. These areas are dominated by a canopy of *Taxodium distichum* (L.) Rich., *Acer rubrum* L., *Nyssa aquatica* L., *Carya aquatica* (Michx. f.) Nutt., *Magnolia virginiana* L. var. *australis* Sarg., *Quercus laurifolia* Michx., *Q. lyrata* Walt., *Q. nigra* L., *Liquidambar styraciflua* L., *Ulmus americana* L., *Fraxinus pennsylvanica* Marsh., *Celtis laevigata* Nutt. and *Pinus elliottii* Engelm. Small trees include *Gleditsia aquatica* Marsh., *Ostrya virginiana* (Mill.) K. Koch, *Carpinus caroliniana* Walt., *Cornus foemina* Mill., and *Planera aquatica* J. F. Gmel. Shrubs occasionally observed were *Cephalanthus occidentalis* L., *Crataegus viridis* L., *Ilex decidua* Walt, *Cyrilla racemiflora* L., *Viburnum obovatum* Walt., *V. nudum* L., *Itea virginica* L., *Sebastiania fruticosa* (Bartr.) Fern., *Hypericum galioides* Lam., *Vaccinium corymbosum* L., *Arundinaria gigantea* (Walt.) Muhl., and *Sabal minor* (Jacq.) Pers. Woody vines observed were *Campsis radicans* (L.) Seem. ex Bureau,

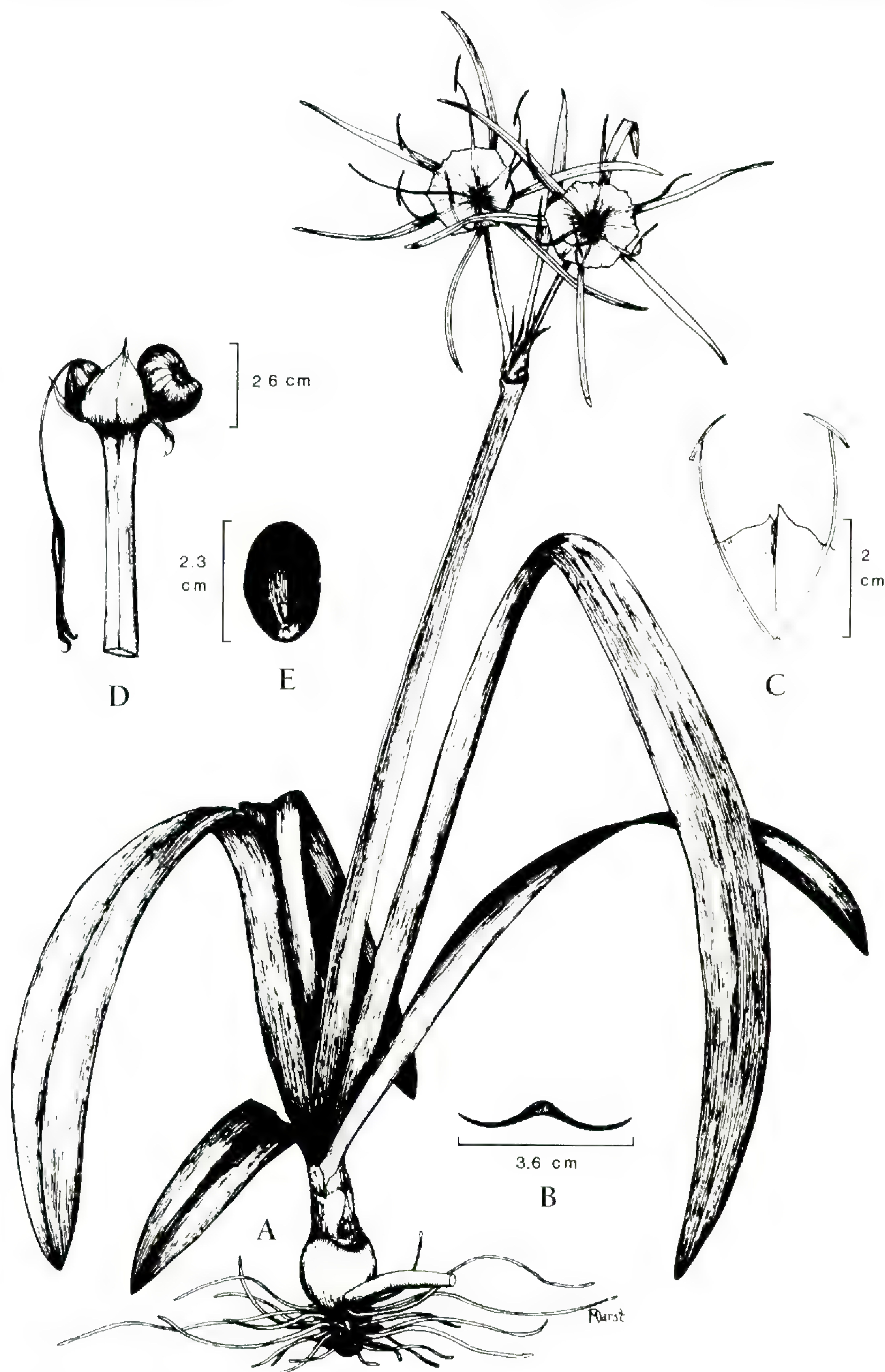
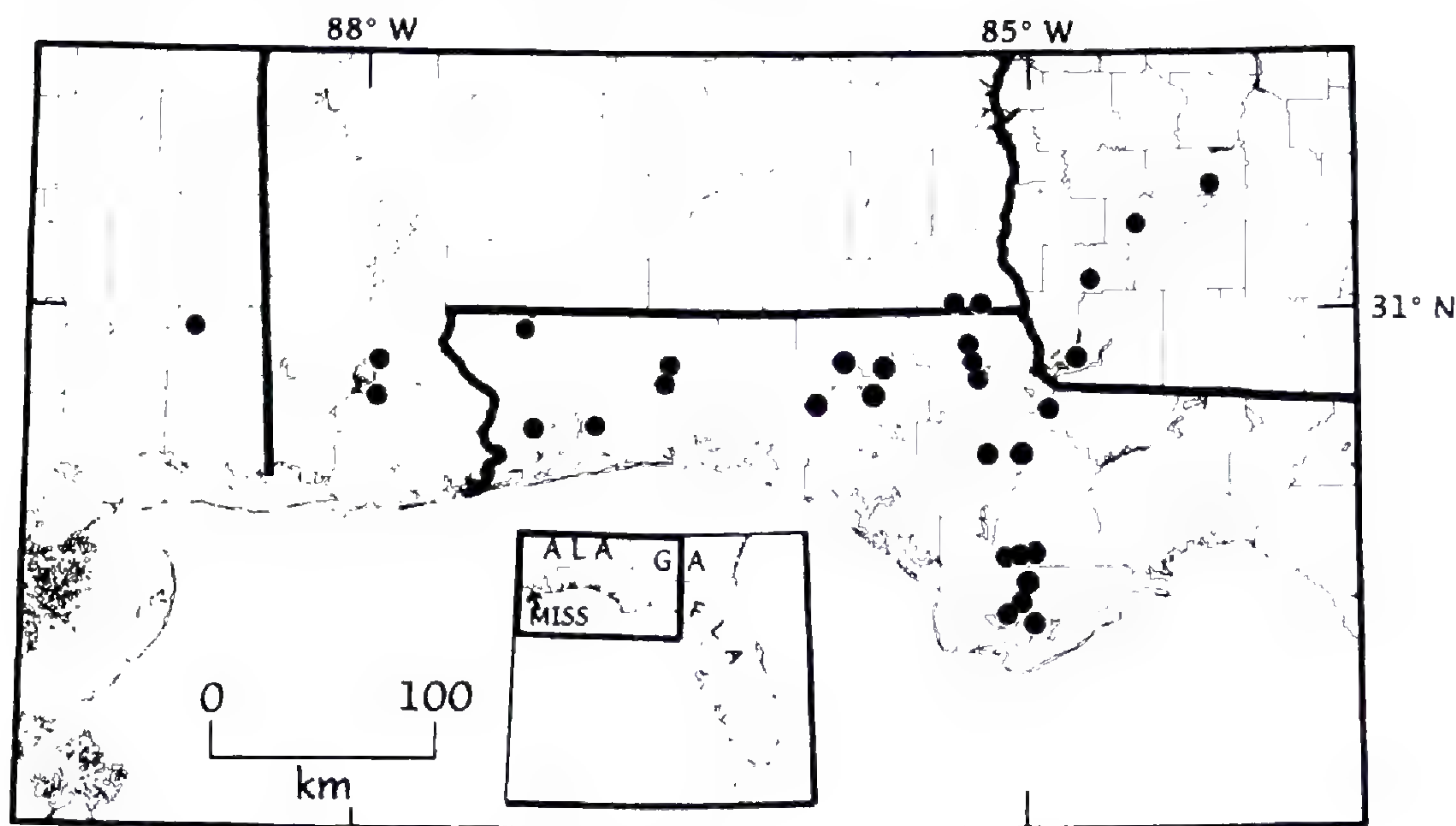


FIG. 2. *Hymenocallis choctawensis* (Smith & Garland 1432). A. Habit B. Leaf cross-section. C. Section of staminal cup. D. Fruit. E. Seed.

FIG. 3. Distribution of *Hymenocallis choctawensis*.

Ampelopsis arborea (L.) Koehne, *Toxicodendron radicans* (L.) Kuntze, *Lonicera japonica* Thunb., *Brunnichia ovata* (Walt.) Shinnery, *Vitis* spp., and *Smilax* spp. and *Clematis* sp. With *H. choctawensis* are herbs such as species of *Carex* including *C. crus-corvi* Shuttlew. ex Kunze, *C. stipata* Muhl. ex Willd., *C. louisianica* Bailey, *Fimbristylis* spp., *Rhynchospora corniculata* (Lamb.) Gray, *Panicum* spp., *Juncus* sp., *Micranthemum umbrosum* (J. E. Gmel.) Blake, *Lobelia* sp., *Viola* sp., *Justicia ovata* (Walt.) Lindau in Urban var. *lanceolata* (Chapm.) R.W. Long, *Zizaniopsis miliacea* (Michx.) Doell, & Asch., *Asclepias perennis* Walt., *Hypoxis* sp., *Hygrophila lacustris* (Schlecht & Cham.) Nees, *Polygonum* sp., *Sagittaria graminea* Michx., *Pontederia cordata* L., *Alternanthera philoxeroides* (Mart.) Griseb., *Cyperus* spp., *Saururus cernuus* L., *Crinum americanum* L., *Samolus parviflorus* Raf., *Myosotis macrosperma* Engelm., *Woodwardia areolata* (L.) Moore, *Lygodium japonicum* Sw., *Osmunda regalis* L., *Myriophyllum* sp., and *Orontium aquaticum* L.

Representative specimens examined: U.S.A. ALABAMA. Baldwin Co.: Historic Blakely State Park, 20 Apr 1985, *Burkhalter & Hodges* 9863 (UWFP). GEORGIA. Baker Co.: Ichauwaynochaway Creek N of SR-200, 17 May 1993, *Kirkman and Drew* 2980 (GA). Decatur Co.: Spring Creek, 19 Jun 1991, *Smith, Godfrey & Gholson* 1535 (FSU). FLORIDA. Calhoun Co.: SR-20 at Chipola River, 26 May 1988, *Smith & Garland* 1461 (FSU); SR-20 at Apalachicola River, 25 Jun 1991, *Smith & Moretz* 1539 (FSU). Franklin Co.: Montgomery Slough, ca. 4.5 air mi NE of Apalachicola, 26 Apr 1985, *Anderson* 8030 (FSU). Gadsden Co.: confluence of Flat Creek with Apalachicola River, 9 Jun 1984, *Gholson* 10923 (FSU, Gholson Herb.). Holmes Co.: 4.8 mi W of Chipley, 24 May 1964, *McDaniel* 4548 (FSU, IBE). Jackson Co.: Hay Spring Run, ca. 5.5 mi W of Greenwood, 26 Apr 1967, *McDaniel* 8836 (FSU, IBE); CR-167 at Chipola River, 12 Jun 1991, *Smith & Gholson* 1526 (FSU); Spring Creek before confluence with Chipola River, 28 May 1995, *Smith &*

Garland 1650 (FSU). **Okaloosa Co.:** Yellow River, NW of Crestview, 11 May 1974, *Godfrey* 73583 (FSU). **Walton Co.:** first stream N of Red Bay on SR-81, 8 May 1959, *Godfrey* 58607 (FSU); ca. 3 mi SE of Knox Hill along Choctawhatchee River, 15 May 1983, *Wilhelm* 11384 (USF). **Washington Co.:** ca. 2 mi N of Caryville, 10 May 1974, *Godfrey* 73518 (FSU, IBE).

Hymenocallis choctawensis is most often misidentified in herbaria as *H. occidentalis* [= *H. caroliniana* of authors, not (L.) Herb.] (Smith et al. 1991). It may also be confused with *Hymenocallis duvalensis*, which is found along floodplains in the Florida panhandle from the upper Ochlockonee River north into Georgia and east across northern Florida. The following key will allow one to distinguish these taxa:

- 1. Leaves oblanceolate, distinctly wider above the middle before tapering; blades 3.5–7.5(–8.5) dm long, 2.5–6 cm wide.
- 2. Leaves coriaceous, nonglaucous; scape bracts 3–4.5(–6) cm long, apex acute but not long-acuminate; bulb ovoid, rhizomatous *Hymenocallis choctawensis*
- 2. Leaves noncoriaceous, glaucous; scape bracts 4–7 cm long, apex long-acuminate; bulb globose, nonrhizomatous *Hymenocallis occidentalis*
- 1. Leaves strap-shaped, not distinctly wider above the middle; blades 2.4–5.5 dm long, 1–2.5 cm wide *Hymenocallis duvalensis*

***Hymenocallis puntagordensis* Traub**

Another *Hymenocallis* species whose identity has been obscure is *H. puntagordensis* Traub (Smith et al. 1994). Traub (1962) based this species on plants he grew from bulbs collected by C.L. Burlingham in Punta Gorda, Florida. A critical examination of the type specimen and a thorough analysis of the original description led to the conclusion that this entity was distinctive and worthy of species status. However, it was perplexing that loans from Florida’s major herbaria (FLAS, FSU, FTG, USF) included no specimens that seemed to match Traub’s entity.

In August 1993 and again in 1995 we observed *Hymenocallis* around Punta Gorda with many-flowered inflorescences on robust, glaucous scapes, and with 5–8 coriaceous, shiny green, strap-shaped leaves. The most striking features were their small, funnelform staminal cups with distinctive marginal projections. These specimens were similar in both quantitative and qualitative characters to the type of *H. puntagordensis*.

Our original collection, *Smith & Garland* 1625, and the type also shared the same chromosome number, $2n=46$ (Flory 1976; Smith et al. 1994). However, the karyotype of the type collection was unknown. From our collection, the first author prepared a karyotype that showed 34 two-armed chromosomes and 12 telocentric chromosomes (Fig. 4). One of the chromosomes of the largest pair showed a distinct satellite on the short arm in every figure in which this chromosome was clearly observable. From all the

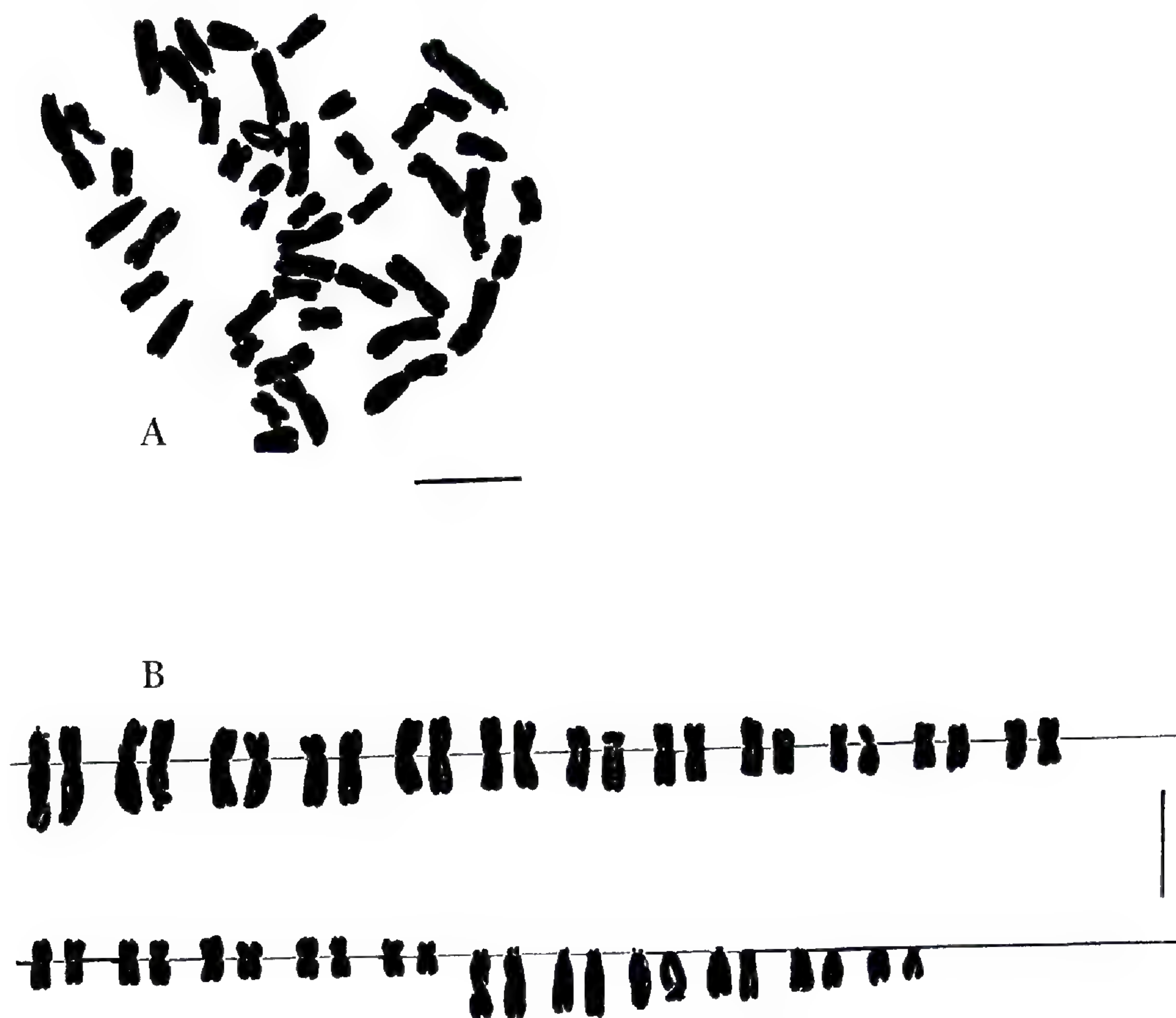


FIG. 4. Chromosomes of *Hymenocallis puntagordensis*, $2n=46$. A. Mitotic metaphase, *Smith & Garland* 1625. B. Karyotype, 34 two-armed chromosomes, 12 telocentrics. The scale equals 10 micrometers.

information available to us, we concluded that our collections were *H. puntagordensis*.

Our collections provided us with bulb characteristics that Traub had not documented for *Hymenocallis puntagordensis*. The bulbs we examined were nonrhizomatous and ovoid, with an elongated neck and a chestnut-brown tunica.

Hymenocallis puntagordensis Traub, *Plant Life* 18:71. 1962. (Fig. 5).

TYPE: UNITED STATES. FLORIDA: Charlotte Co.: from bulbs collected by C.L. Burlingham, specimen *Traub* 878 *a + b + c* (HOLOTYPE: MO! ex TRA).

Bulb nonrhizomatous, ovoid, $5-8 \times 2-4.5$ cm, neck long, (5-)8-12 cm, basal plate 1-2 cm; tunica dark-brown. *Leaves* 5-8, evergreen, suberect, shiny green, narrowly strap-shaped, channeled proximally, $3.5-7.5$ dm $\times$ 1.5-3 cm, highly coriaceous, apex acute. *Scape* 5-6 dm, distinctly two-edged, glaucous; two scape bracts enclosing the buds, $4-6$ cm $\times$ ca. 15



FIG 5. *Hymenocallis puntagordensis* (Smith & Garland 1625). A. Habit. B. Leaf cross-section. C. Inflorescence. D. Section of staminal cup.

mm; each flower with a subtending bract, 3–5.5 cm $\times$ 5–10 mm. *Flowers* 2–8, opening sequentially, fragrant; perianth segments ascending, green on keel, (7–)9.5–11.5 cm $\times$ 4–6 mm; perianth tube green, (6–)7.5–12 cm; staminal cup white with small yellow-green eye, funnelform, 2–2.8 $\times$ ca. 3 cm, margin with one or two prominent lacerate projections between the free filaments; free filaments slightly curved, inserted on a flat base, green in distal half but fading to white proximally, (2.5–)3.5–4.5 cm; anthers 1.3–2 cm, pollen yellow; style green in distal half, fading to white proximally, 13–22 cm; ovary pyriform, 15–24 $\times$ ca. 10 mm; ovules 5–9 per locule. *Fruit* pyriform (immature). *Seeds* unknown. $2n=46$ (Flory 1976; Smith et al. 1994).

Hymenocallis puntagordensis, the small cup spider-lily, has been found along a roadside bordering disturbed pine flatwoods and along the banks of a railroad in a waste area in the vicinity of Punta Gorda, Florida (Fig. 6). It is possible that this species may occur in other areas of central and south Florida. Flowering and fruiting are known to occur in August and probably into September.

Distinguishing features are the small, funnelform staminal cup with distinct projections; an elongated, pyriform capsule; suberect, coriaceous, narrowly strap-shaped leaves; and ovoid bulb with an elongated neck. It is likely that specimens of *H. puntagordensis* have previously been misidentified as *H. latifolia* (Mill.) Roem. Plants that have densely multiflowered inflorescences, perianth tubes exceeding 10 cm long, and long strap-shaped leaves bear a striking resemblance to *H. latifolia*. However, a closer examination reveals that the small staminal cup margin has prominent projections, the pollen is yellow, the ovaries are large and pyriform with up to nine ovules per locule, and the leaves are narrowly strap-shaped. *Hymenocallis latifolia*, in contrast, has a staminal cup without prominent projections, orange pollen, an ovoid ovary with two or three ovules per locule, and leaves that may approach a decimeter in width.

Along the roadside in the border of the disturbed flatwoods were scattered individuals of *Pinus elliottii* Engelm., *Myrica cerifera* L., *Schinus terebinthifolius* Raddi and *Sabal palmetto* (Walter) Lodd. ex Schultes. The individuals of *Hymenocallis puntagordensis* were found along the slope of a drainage ditch in association with *Hymenocallis palmeri* S. Watson, *Paspalum notatum* Fluegge, *Dichromena latifolia* Baldwin, *Cyperus* spp., *Fuirena* sp., *Ludwigia octovalvis* (Jacq.) P.H. Raven, *Sagittaria lancifolia* L., and *Pontederia cordata* L. South of Punta Gorda, *Hymenocallis puntagordensis* grew on fill along a railroad track bordered by *Pinus elliottii* Engelm. var. *densa* Little & Dorman, *Schinus terebinthifolius* Raddi, and *Myrica cerifera* L. The groundcover included such species as *Cyperus ligularis* L., *Paspalum urvillei* Steud., *Aristida*

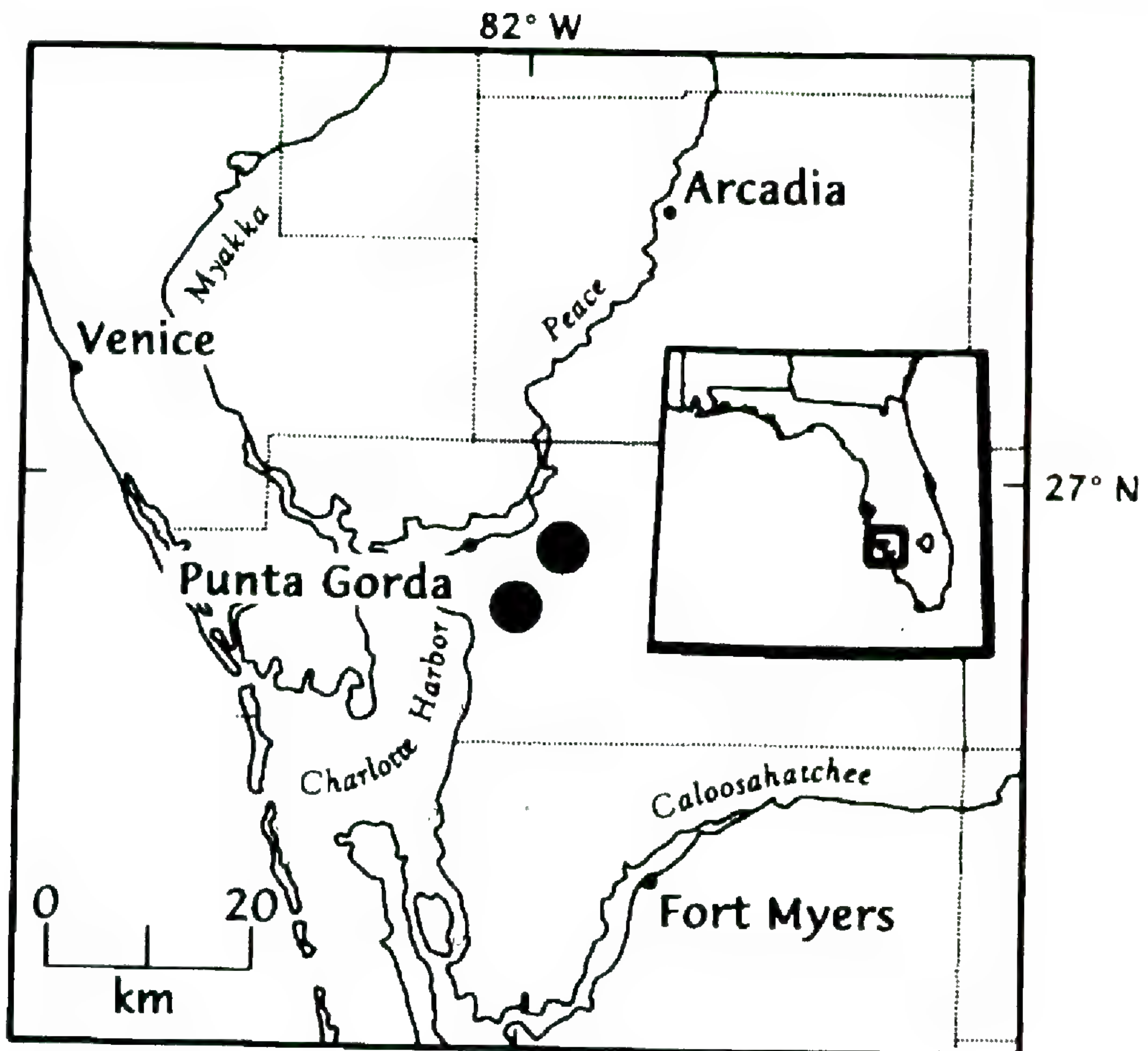


FIG 6. Distribution of *Hymenocallis puntagordensis*.

gyrans Chapm., *Heteropogon contortus* (L.) P. Beauv. ex Roem. & Schult. and *Conyza canadensis* (L.) Cronquist, all of which are colonizers of disturbed sites.

We regard the information that we have presented on *Hymenocallis puntagordensis* as preliminary. As opportunities arise, we plan to gather more information about its morphology, distribution, and relationships. One question to be investigated further is the native habitat of the species. We have so far found it only in disturbed sites, leading to the suspicion that it may not be native to Florida. Nevertheless, we believe it is native because of the large pyriform ovary with 5–9 ovules per locule, the yellow pollen, and the funnelform staminal cup with lacerate margin, characteristics of the native Florida species in Traub's *Henryae* alliance. We have encountered some plants that have flowers that are remarkably similar to those observed in *Hymenocallis palmeri*, a community associate. We would appreciate any information about additional populations of this species from collectors of *H. puntagordensis* in SW Florida.

Representative specimens examined: U.S.A. FLORIDA. Charlotte Co.: E of jct. of US 17 & CR-74 along 74, 10 Aug 1993, *Smith & Garland* 1625 (FSU); S of Punta Gorda along US 41 near railroad tracks, 12 Aug 1995, *Smith & Garland* 1665 (FSU).

After this article was reviewed, and it was revised and resubmitted for publication, we became aware of a paper by Laferriere (1996) in which he republishes several Traub names—*Hymenocallis choctawensis* and *H. puntagordensis*, as well as *H. henryae*, *H. moldenkiana*, and *H. palusvirens*,—because Traub's holotypes are multiple sheets rather than the "single specimen" required by the Code. We question whether this is necessary.

Large, hard-to-press plants, such as palms and fleshy amaryllids, may require more than one sheet (or a box, or a formalin jar) for a diagnostic specimen. Molloy et al. (1992a) discussed this problem and proposed a modification of Article 9.1 of the Code that would allow a holotype, lectotype, or neotype to consist "of more than one herbarium sheet or equivalent, so long as all parts come from a single gathering or are stated in the protologue to have been collected from the same individual at different times" (Molloy et al. 1992b; Greuter & McNeill 1993). Though this proposal is still being studied by a Special Committee on Lectotypification, it drew broad support at the Tokyo Botanical Congress in 1993 (McNeill 1993), and this broad definition of "single specimen" could be applied under the present Code.

We have carefully studied the type specimens of each of these species and are certain that the multiple sheets in each holotype represent parts of a single plant. We believe this because individual sheets represent various plant parts such as the scape, leaves, and individual flowers of an inflorescence. It is rather easy to visualize the assemblage of all the various parts into a single plant. For example, there is only one scape per specimen, and the total number of flowers on all sheets matches that expected for a single plant of each species. Further supporting our concept of a single plant for each holotype is that Traub (1962) himself referred to each holotype as a single specimen, and the date of collection on all sheets of a single type specimen is the same. We, therefore, believe that the republication of these names by Laferriere (1996) is not strictly necessary, and may even be harmful by making diagnostic parts of a single plant, formerly part of the holotype, nomenclaturally irrelevant.

ACKNOWLEDGMENTS

The authors are grateful for herbarium loans extended by FLAS, FSU, FTG, GA, IBE, UNCC, USCH, USE, VS and Angus Gholson. The Missouri Botanical Garden is thanked for the opportunity to study the Traub type collection. Josephine deN. Henry graciously allowed the first author to study her mother's field diaries at the Henry Foundation, Gladwyne, PA. Angus Gholson, Robert Godfrey, Loran Anderson, Craig Moretz, and Gary Knight are thanked for their field assistance in our Florida panhandle studies. We thank John Tobe for bulb collections and expanding our list of

associates for *Hymenocallis choctawensis*. Ken Gordon and John McDonald are thanked for providing bulb collections of this species in Mississippi and Alabama. Additionally, we thank Gary Knight for sharing with us a number of excellent slides of Florida panhandle spider-lilies. A special thanks is extended to Melanie Darst for sharing her considerable artistic talents with the spider-lilies in the preparation of the fine illustrations. Walter Flory is thanked for providing helpful, critical comments on the cytological preparations. Dean Koonts is acknowledged for his assistance in obtaining measurements of *Hymenocallis choctawensis* from pressed specimens. Fred Yeats, Chair and Professor of Biology at High Point University, is thanked for his support of this study. Barney Lipscomb, editor and the reviewers, Alan Meerow and Aaron Davis, provided helpful suggestions and comments in the revision of the article. Funding for the research was provided in part by a North Carolina Board of Science and Technology grant, number 90SE010 and High Point University. Sharyn Carpenter expeditiously supplied word processing of the manuscript. Susan Linker, High Point University, provided the Spanish abstract.

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BOOK NOTICE

LINES, WILLIAM J. 1996. *An All Consuming Passion, Origins, Modernity, and the Australian Life of Georgiana Molloy*. (ISBN 0-520-20422-0, pbk.) University of California Press, Berkeley and Los Angeles, California, University of California Press, Ltd., London, England \$14.95. 398 pp, 18 b&w illustrations, 3 maps.

In 1829, Georgiana Molloy, married only three months, left England with a husband twice her age, retired Napoleonic War veteran, Captain John Molloy. Early with child and bound on a grueling six month sea journey to become apart of a new British colony of Swan River in the wilds of west Australia, Georgiana shows a inner determination and endurance.

Looking forward to what was promoted as "England with a finer sky," where settler could dine on roast swan, kangaroo and black cockatoo, they quickly found the reality was flies, fleas, and mosquitoes. As winter rains beat down, kneeling on a wooden box in a cold and leaky tent Georgiana delivered her baby on the ground. Nine days later the child was dead. She was to bear six more children before septicemia killed her at age thirty-eight. Mortality was high for the newborn colonists and the women. Before her death, however, she develops a passion for the Australian flora.

Sometimes Lines' long narratives tested *my* endurance, but just in time, he seems to bring me back to life with the exhaustive research and detail in the day to day life of both settlers and Aborigines and many exurpts from Georgiana's diaries and letters. Contrasts are clearly found between the anglo ideal 'of subduing a land into a garden' to that of the native Aborigine who found no difference between picturesque landscape and wilderness. Aboriginal belief was in the Dreamtime sung into existence by ancestors—a living with the land rather than taming it.

An All Consuming Passion is about, not only Molloy's increasing passion for Australian botany, but her fellow neighbors increasing desire ... "(for self-improvement, for getting on, for money) and, by extension, to the modern world's (for power, for conquering nature)." and what an impact these passions have on nature.—*Linny Heagy*.

TAXONOMIC NOTES ON THE *CENTROSEMA* *PUBESCENS* BENTHAM COMPLEX IN CENTRAL AMERICA (LEGUMINOSAE: PHASEOLEAE: CLITORIINAE)

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ABSTRACT

Two species in Central America are known by the name *Centrosema pubescens* Benth. Description and differentiation of the two taxa are presented, along with a record of the nomenclatural history of confusion with other species [*C. galeottii* Fantz, *C. macrocarpum* Benth., *C. molle* Mart. ex Benth., *C. schiedeanum* (Schlecht.) Williams & Clements, and *C. virginianum* (L.) Benth.], and commentary on the type specimen of *C. pubescens*. Evidence from the type indicates the name *C. pubescens* should be applied to an upland Central American species currently known as *C. galeottii* or *C. schiedeanum*. The widespread, lowland tropical species bearing the name *C. pubescens* must be renamed, with *C. molle* having priority.

RESUMEN

En Centroamérica son conocidas dos especies con el nombre de *Centrosema pubescens* Benth. Se presenta la descripción de los dos taxa, junto con la historia nomenclatural de confusión con otras especies [*C. galeottii* Fantz, *C. macrocarpum* Benth., *C. molle* Mart. ex Benth., *C. schiedeanum* (Schlecht.) Williams & Clements, y *C. virginianum* (L.) Benth.], y un comentario sobre el tipo de *C. pubescens*. Una vez examinado el tipo aparecen evidencias que indican que el nombre de *C. pubescens* debe ser aplicado a una especie de las tierras altas de Centroamérica conocida normalmente como *C. galeottii* o *C. schiedeanum*. La especie tropical de las tierras bajas conocida como *C. pubescens* debe ser renombrada, teniendo prioridad *C. molle*.

INTRODUCTION

Centrosema pubescens Benth (Leguminosae, Phaseoleae, Clitoriinae) as treated by most authors is a neotropical species distributed from Mexico to Peru to Brazil. It has been introduced into the paleotropics as an ornamental vine or forage crop, and naturalized in Africa, Southeast Asia, Indonesia and Australia. It is an important, widely cultivated, species undergoing intensive research by agriculturalists (Schultz-Kraft & Clements 1990). Examination of Central American specimens has shown that the type specimen of *C. pubescens* belongs to another species often confused with it. The cultivated species should be renamed and a second species, unknown except to a few botanists, should bear the name of *Centrosema pubescens* Benth.

CENTRAL AMERICAN "PUBESCENS" TAXA

Herbarium material named *C. pubescens* from Central America represents two distinct taxa. They will be referred to as Taxon A and Taxon B to simplify my discussion and to avoid confusion that would arise from using names. Table 1 compares distinguishing characters of these taxa.

Taxon A is widespread from Mexico to Peru and Brazil at 0–500 m, rarely to 800 m, and is the most commonly vouchered taxon of *Centrosema* in Central America. Collectors cite the habitat as grasslands, forest clearings or secondary vegetation, thickets, and pine-oak forests or subtropical montane forests. This is the agriculturally important species that has been introduced into Africa, southeast Asia, Indonesia and Australia. Leaves are short pilose-hispidulous above with uncinata trichomes on the midrib, densely short-pilose on major veins below, with age glabrescent. Flowers are white with a medial yellow stripe and purplish veins, pigmentation intensifying as the flower matures with lilac hues between the veins, thus "white or pale lilac" as noted by collectors. Bracteoles are uncinata-pubescent on the ventral third to half portion of the abaxial surface, glabrescent over the rest. The dorsal teeth of the calyx are fused to near the apex. The calyx is glabrescent with micro-uncinate trichomes prominent on teeth and more or less on the ventral surface. Fruits are 6–7 mm wide and immature ones are falcate to subfalcate in the upper half, but straighten with age. The pod valves become purplish-brown over the seeds, giving the appearance of transverse dark bands which fade with age, and are not conspicuous in all material of juvenile/immature fruits.

Taxon B is distributed from Mexico to western Panama at elevations of 500–2200 m. Collectors cite the habitat as ravines, limestone ridges, or black (volcanic) sandy soil associated with pine-oak-sweetgum forests or rain forests. This species has been relatively unknown to botanists until recent years. Leaves are short pilose-hispidulous above with uncinata trichomes on the midrib, densely pilose on the major veins below, glabrescent with age. Flowers are violet. Bracts are densely sericeous with trichomes long appressed, or ascending and spreading slightly at the apex. Pedicels are densely pubescent through the fruiting stage with ascending-appressed to spreading trichomes 1–2 mm long. Bracteoles are densely sericeous in bud; the abaxial surface is densely covered with long ascending trichomes that are deciduous as the flower matures to expose micro-uncinate trichomes only on the ventral half, although the dorsal half does thin with age. The calyx pubescence is prominently moderately sericeous with long ascending trichomes on the ventral (plus some dorsal) surface of the calyx tube that are deciduous with age, exposing dense micro-uncinate trichomes. Fruits are 6–8 mm wide and immature ones are falcate to subfalcate in the upper

TABLE 1. Comparison of two taxa known as *Centrosema pubescens*.

Character	Taxon A	Taxon B
Habitat elevation	0–500 (800) m	500–2200 m
Stipules	2–3 mm Deltate	3–5 mm Lance-deltate
Petiolules	2–3 (4) mm	(2) 3–5 mm
Bracts	4–6 × 1–2 mm Puberulous	6–9 × 3–6 mm Sericeous
Pedicels:		
In flower	6–9 mm Sparsely strigose	3–6 mm Sericeous
In fruit	9–12 mm Glabrescent	8–12 mm Thinly sericeous
Bracteoles	6–9 × 4–6 mm Uncinate-puberulous	10–16 × 6–9 mm Sericeous & uncinata-puberulous
Flowers	white, pale lilac	violaceous
Calyx teeth		
Dorsal & lateral	2–3 mm	3–5 mm
Ventral	5–7 mm	5–8 mm

half, but straighten with age. The pod valves become purplish-brown above the seeds, giving the appearance of dark spots to occasionally dark bands, but the bands are less prominent in this species and also fade with age.

Both taxa are confused with *C. macrocarpum* Benth. which can be distinguished by the broader calyx tube (7–9 mm diam.), elongated ventral lobe of the calyx (8–15 mm long), larger bracteoles (10–16 mm long × 5–9 mm wide) than Taxon B, but glabrate or sparsely uncinata-pubescent in the ventral half on the abaxial surface, fruiting pedicels that are thinly pubescent and broader fruits (8–10 mm wide).

Taxon A is confused frequently with *C. virginianum* (L.) Benth. which is recognized by its five elongated, subequal calyx lobes (5–9 mm) that exceed the tube (3–4 mm × 4–5 mm), by the violaceous flowers, and by the narrower fruit (4–5 mm wide).

MODERN TREATMENTS

Is *C. pubescens* Taxon A or Taxon B? Evidence from the literature indicates either taxon is *C. pubescens*, depending upon the author’s interpretation. A chronological history of the nomenclature is presented for the reader’s understanding of the problem.

Bentham (1837) originally described *C. pubescens* citing “Ad Tlalpuxahua Mexicanorum. Keerle in herb. Martius.” The bracts were described as sericeo-

villous and bracteoles as sericeous on the outer surface. Benthams (1837) also originally described *C. molle* citing "In pascuis et pratis ad Para, et in sepibus ad Barra do Rio Negro. Martius." Bracteoles were described as puberulous. The calyces for both taxa was described as having four short teeth and a long vexillary tooth. Based upon the bracts and bracteoles, *C. pubescens* fits Taxon B and *C. molle* fits Taxon A.

Benthams in *Flora Brasiliensis* (1859) recognized one species in Brazil as *C. pubescens*, with *C. molle* cited in synonymy. The bracteoles were noted as puberulous. The description agrees with Taxon A, but it should be noted that Taxon B does not occur in Brazil.

Rose (1903) reported that at the type locality of *Bradburya schiedeana* (Schlecht.) Rose [basionym: *Clitoria schiedeana* Schlecht.] near Jalapa, Mexico. He found the plant in great abundance, cited his own collection as 6118 [Rose & Hay 6118 (NY!)] and also the basionym type, *Schiede* 608 (HAL! - annotated as *C. pubescens* by me in early 70s). Both agree with Taxon B.

Identified material at the Field Museum of Natural History (F) follows the Costa Rican treatment of Standley (1937) and the Guatemalan treatment of Standley and Steyermark (1946). Specimens with the "bracts and bractlets [=bracteoles] densely sericeous with long appressed hairs" were identified as *C. pubescens*, following Benthams (1837), and agree with Taxon B. Specimens with "bracts and bractlets puberulent" were identified as *C. virginianum*. Specimens of this taxon at F from Costa Rica and Guatemala were identified as *C. virginianum*, supporting the treatments of Standley (1937) and Standley and Steyermark (1946). The published description of their species is a mixture of two taxa, the "puberulous" one [=Taxon A] and *C. virginianum*. Most authors recognize *C. virginianum* as a distinct species.

Barbosa-Feverheiro (1977) provided a taxonomic treatment of *Centrosema* for Brazil. This is the first revisionary treatment of the genus in over a century, thus one utilized as authoritative by modern authors. Her annotations of Central American specimens supported her treatment of *C. pubescens* as a valid species. She annotated the type (at BR) in 1975. Placed in synonymy were *C. molle* Benth. and *C. schideanum* [as *Clitoria schiedeana* Schlecht.] Thus, the two taxa under discussion were treated by her as one species, following Benthams (1859).

Fantz (1979) provided a key to species of *Centrosema* reported to occur in Central America. Plants with the smaller bracteoles were identified as *C. pubescens*. Those with the larger sericeo-pilose bracteoles were identified as *Clitoria grandiflora* Mart. & Gal. The name *Centrosema grandiflorum* (Mart. & Gal.) Walp. is a later homonym of *Centrosema grandiflorum* Benth. (1837). Therefore, Fantz proposed the name *C. galeottii* lectotypified by *Galeotti* 3284. Many Central American specimens have been identified as *C. galeottii* (e.g. CR, ENCB, MEXU, MO), presumably following this publication.

R.J. Williams and R.J. Clements (CSIRO) in the latter 1970s began revisionary studies on the genus *Centrosema*. The type of *C. pubescens* (BR) was borrowed in 1978. R.J. Williams annotated Hinton 7072 (K) with the following note, dated Jan '82: "On *Centrosema pubescens* Benth. Much of the material reference to this species by modern authors I find not to be conspecific with the type (Keerle, Tlapujahua Mexicana - BR ex herb Martii!). It remains for me to find a name for such material. Hinton 7072 is certainly "aff." *C. pubescens*." In the absence of flowers, bracteoles etc., one cannot place it with certainty. A lot of "*C. pubescens*" at K is NOT conspecific with the type, but this other material is not represented in my 1981 determinations." Sheets annotated by R.J. Williams as *C. pubescens* Benth. *sensu stricto* agree with Taxon B, whereas others representing the majority of specimens annotated as *C. pubescens* fit Taxon A. Galeotti 3284 (K!) was annotated by R.J. Williams as *C. pubescens* and it agrees with Taxon B.

D'Arcy (1980) recognized only one species in Panama, *C. pubescens* with smaller bracteoles. He reported the type as "?M, not seen." D'Arcy reported two collections from Panama as conspicuously different in appearance, with much denser and longer pubescence on the bracteoles and bracts. He noted that an examination of other collections in Central America did not produce intermediates. He reported that Bentham's original description of the bracteoles and bracts matched these specimens, not the less pubescent plants that are widespread. D'Arcy was the first to report in literature that "recognition of more than one taxon might require renaming of the commoner plants rather than the unusual plants."

McVaugh (1987) recognized *C. pubescens* with the smaller bracteoles "uncinate-pubescent distally" as part of a widespread, lowland race (100–700 m) commonly encountered. He reported a higher elevation race (800–1400 m) with silky-pilose bracteoles, one rarely encountered (3 specimens cited) that was equivalent to Standley & Steyermark's *C. pubescens* (1946) and D'Arcy's reported unusual plants (1980).

A workshop on the biology, agronomy and utilization of *Centrosema* was held in 1987 at the Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. Schultze-Kraft and Clements (1990) edited a volume with contributions from 52 authors that summarized the knowledge of *Centrosema* and its potential for providing additional species besides common centro (*C. pubescens* Benth.) for increased animal production and cover crops in plantation agriculture.

Williams and Clements (1990) presented the taxonomy of *Centrosema*, including a key and a table of recognized species, synonyms and sources of best descriptions. They recognized a species in Central America as *Centrosema schiedeanum* (ined.), noting by footnote the basionym as *Clitoria schiedeana* Schlechtendal, 1838. In effect, they validly published this new combina-

tion, and it should be cited as *Centrosema schiedeanum* (Schlecht.) Williams & Clements. This name was used for Taxon B. Williams and Clements (1990) recognized *C. pubescens* Benth. as a separate species, which is equivalent to Taxon A.

Schultze-Kraft et al. (1990) presented the biogeography of *Centrosema*, including maps of natural distribution for each species recognized. *Centrosema pubescens* (map 8) illustrates a wide-spread neotropical distribution whereas *C. schiedeanum* (map 5) is confined to an area from Mexico to central Panama with a few collections [introduced?] in Colombia.

Herbarium material of *Centrosema* from Central America has been examined by me in the 1990s for a treatment of the genus in *Flora Mesoamerica*. Identification of species of *Centrosema* are based historically upon characters of the bracteoles, the calyx teeth plus comparisons of the teeth length to the tube, floral color, and fruit size. Vegetative characters are less important, for a number of species exhibit infraspecific variation (e.g. leaflet size and shape) and similarity of characters with those of other species (e.g. growth form, stipules, vestiture). Most species in the *C. pubescens* complex are confused by modern botanists with one or more different species (i.e. *C. galeottii* Fantz, *C. macrocarpum* Benth., *C. schiedeanum*, *C. virginianum* (L.) Benth.) as evidenced by their misidentification of herbarium specimens. Several problems can occur in identification of herbarium material. Bracteoles commonly are larger than the calyx and obscure it, but are deciduous and are lacking in fruiting specimens. The calyx shrinks slightly as the fruit matures, and the longer ventral lobe often is broken. Mature fruits of herbarium specimens with evidence of dehiscence often have only remnants of calyces. Fruits of several species of *Centrosema* are similar or overlap in size. Fruiting specimens are most difficult to identify.

Examination of Central American material supported the conclusion presented by Williams and Clements (1990) at the conference. Material known traditionally from Central America as *Centrosema pubescens* includes two distinct taxa.

TYPE OF *CENTROSEMA PUBESCENS*

Bentham (1837) cited "Ad Tlalpuxahua Mexicanorum. Keerle in herb. Martius" for *C. pubescens*. D'Arcy (1980) suggested the type was at M, but Dr. H. Hertel (M, pers. comm.) reported that M does not have this specimen. Stafleu and Cowan (1981) reported that Martius' type specimens are at München (M), but types of species described by other authors are to be sought at Brussels (BR). The type of *C. pubescens* is deposited at BR, and annotated by Barbosa in 1975, but not by Williams.

The herbarium sheet (Fig. 1) at BR contains at least two and possibly three collections. Mounted on the left is *Wulfschlägel* 129 collected in 1858

from Gracehill Ant [Antigua, West Indies], and identified as *C. pubescens* Benth. - *molle* Mart. mss. Mounted on the right is a second specimen with a pencil notation at the top ("250") and a short line pointing to the specimen. This material agrees with the specimen mounted on the left. A third specimen in a plastic sleeve (Fig. 2) overlays this specimen (Fig. 1), attached by a paperclip, with a pencil notation ("72A") and an arrow drawn to it. Mounted on the right is an herbarium label as "Tlapujahua Mexicanor, T.W. Keerl, 1829."

The mounted specimens with both flowers and fruits belong to Taxon A. The dissected flower mounted on a small sheet and pasted in the upper left corner (presumably by Barbosa) belongs to Taxon A. The small specimen (Fig. 2) consisting of a flower lacking bracts & bracteoles, one fragmented leaf, and a few additional peduncles belongs to Taxon B and matches most closely Bentham's (1837) protologue.

The U.S. Office of Geography (1956) indicated the correct name to be Tlapujahua de Rayón (19°48'N, 100°10'W), not spelled with the "x" as cited by Bentham (1837). This populated site commonly is lacking in atlases. The Operational Navigation Chart (1985) mapped Tlapujahua in the upland mountains just west from El Oro (Ixtapan del Oro), and across the border into the state of Michoacán.

DISCUSSION

Barbosa-Ferevereiro (1977) cited "Holótipo: Ad Tlapuxahua Mexicanorum. Keerle." as the type for *C. pubescens* Benth. Questions arise regarding the Keerle specimen. Are there one or two Keerle specimens? Who annotated the samples on the right with numbers and drew lines to the material? When those numbers were added and upon what basis is unknown.

The specimen mounted on the right does not match the original diagnosis (sericeous bracts & bracteoles) nor is this specimen in agreement with those collected in upland mountain habitats (Taxon B). This specimen agrees with Taxon A, a lowland species. The specimen on the right may represent more material of *Wulfschlägel* 129, or a second collection (no. 250?) by Wulfschlägel from Antigua, but it is not type material.

The specimen (Fig. 2) in the plastic sleeve matches closely with Bentham's (1837) protologue, and is in agreement with the upland species (Taxon B) that matches the type locality. This specimen is *C. pubescens* Benth., *sensu stricto*, from Herb. Martii as cited by Bentham (1837), therefore, it is recognized as the holotype. The number "72A" will be disregarded in citations as it is unknown if it indeed applies to the Keerle specimen.

Bentham (1859) recognized both Taxon A and Taxon B as a single species *C. pubescens*. Do these taxa belong to the same species? These taxa are treated as *C. pubescens*, *sensu lato*, by Barbosa-Ferevereiro (1977), D'Arcy (1980)



FIG. 1. Photograph of herbarium sheet (BR) that contains the cited type (Keerle: Ad Tlapajuhua, Mexico) for *Centrosema pubescens* Benth.



FIG. 2. The BR specimen, removed from plastic sleeve in Fig. 1, that agrees with Benthams protologue of *Centrosema pubescens*.

and McVaugh (1987), although the latter two recognized a few specimens as distinct. Should they be treated as infraspecific taxa of one species? Standley (1937), Standley and Steyermark (1946), Fantz (1979), and Williams and Clements (1990) segregated these taxa as distinct species in Central America, but utilized different names (or recognized such in notes). A number of modern botanists working in Central America are distinguishing these taxa as two distinct species as evidenced by annotation labels on herbarium sheets examined for the *Flora Mesoamerica* project.

CONCLUSION

Evidence indicates that two distinct species are recognized as *C. pubescens*. Which taxon should bear the name *C. pubescens*? Evidence from the holotype indicates that it is Taxon B. In addition, the names *C. galeottii* and *C. schiedeana* agree with Taxon B, and should be placed in synonymy. Therefore, the following nomenclature is produced for Taxon B:

Centrosema pubescens Benth., Comm. Leg. Gen. 55. 1837; Ann. Wiener Mus. Naturgesch. 2:119. 1839. *Bradburya pubescens* (Benth.) O. Ktze, Revis. Gen. Pl. 1:164. 1891. TYPE: MEXICO. MICHOACÁN: Ad Tlalpuxahua Mexicanorum. *Keerle* s.n. (HOLOTYPE: BR—ex hb. Martius, mounted in a plastic sleeve and paperclipped to the herbarium sheet above another specimen — cf. Fig. 1).

Clitoria schiedeana Schlecht., Linnaea 12(3):284. 1838. *Bradburya schiedeana* (Schlecht.) Rose, Contr. U.S. Natl. Herb. 8:46. 1899. *Centrosema schiedeana* (Schlecht.) Williams & Clements. In: Schultze-Kraft and Clements, eds. *Centrosema: Biology, Agronomy, and Utilization*, p. 7, tab. 1 (as *ined.*). 1990. TYPE: MEXICO. VERA CRUZ: In dumetis pr. Jalapam Aug, Hacienda de La Laguna, Sep, *Schiede* 608 (LECTOTYPE, here designated: HAL 36864; ISOLECTOTYPES: B-destroyed, HAL 34078-sh. 1!, HAL 34078-sh. 2!, HAL 37536!)

Clitoria grandiflora Mart. & Gal., Bull. Acad. Brux. 10:189. 1843. *Centrosema grandiflorum* Walp., Repert. bot. syst. 5:529. 1846. (*non* Benth. 1837). *Centrosema galeottii* Fantz, Sida 8:155. 1979. TYPE: MEXICO. VERA CRUZ: fl. lilac, bois, Cordillère, 3000 pied., Jun–Oct 1840, *H. Galeotti* 3284 (LECTOTYPE: BR!-designated by Fantz, Sida 8:155. 1979; ISOLECTOTYPES: K!- hb. Hook., TEX!-photo of G).

Taxon A now must be renamed. A name is available from synonymy that now has priority. Nomenclature for Taxon A is as follows:

Centrosema molle Mart. ex Benth., Comm. Leg. Gen. 55. 1837; Ann. Wiener Mus. Naturgesch. 2:119. 1839. SYNTYPES: BRAZIL. RIO NEGRO: *Clitoria* flore amplo, albo, vexillo in medio s*** [?] violaceas, in sylvis ad Barra do Rio Negro, *Martius* s.n. (M 12505!). BRAZIL. Para: in pascuis et pratis, ad Para, *Martius* (M).

Centrosema pubescens Auth.; Benth. In: Martius, Fl. Bras. 15:131. 1859; Barbosa-Ferevereiro. Rodriguésia 42:184. 1977; *non* Benth. (1837).

Centrosema virginianum L. *pro parte*, Standley. Flora Costa Rica. Publ. Field Mus. Nat. Hist., Bot. Ser. 18:528. 1937; Standley & Steyermark. Flora of Guatemala, Fieldiana, Bot. 25:181. 1946; *non* L.

ADDITIONAL TYPE NOTES

Schlechtendal (1838) cited one collection of Schiede in his protologue for *Clitoria schiedeana*, but did not cite an institution of deposit. Types of both Schlechtendal and Schiede material are deposited at B and HAL, with potential duplicates at several other institutions (Stafleu & Cowen 1985). Berlin material was destroyed in World War II. Four sheets were found at HAL with these duplicates incorporated into the collection on three different dates. These are treated as syntypes, as discussed by Fantz (1993). The lectotype designated herein bears the name *Clitoria schiedeana* sp. nov. and agrees best with the protologue.

Martius type specimens are at M with types of species of other authors often at BR (Stafleu and Cowan 1981). Curator Paul Bamps (BR, pers. comm.) reported that types for *C. molle* were at M, not in their collection. Only one sheet, the Rio Negro syntype (M) was included in a loan request of types. R.J. Clements (pers. comm.) reported four Martius sheets at M, and recognizes the Para collection (M) to be the lectotype.

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WOOD ANATOMY OF LIMNANTHACEAE AND TROPAEOLACEAE IN RELATION TO HABIT AND PHYLOGENY

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ABSTRACT

Qualitative and quantitative wood data are provided for *Limnanthes douglasii* R. Brown and *Tropaeolum majus* L.; no descriptions of wood of Limnanthaceae or Tropaeolaceae have been offered hitherto. *Limnanthes douglasii* wood is present in localized zones at the root-stem junction; imperforate tracheary elements are absent; both axial and ray parenchyma are thin-walled. *Tropaeolum majus* has root wood in which all axial tracheary elements are wide or narrow vessels, and no libriform fibers are present; in stems, libriform fibers are present, although narrow vessels predominate in later-formed secondary xylem. The wood patterns of *Limnanthes* and *Tropaeolum* are characteristic of wood of an annual and a vine, respectively. Although both are herbaceous species, wood patterns are quite different, a fact explainable by both habit and systematic position. The concept that both of the families belong to a new expanded Capparales is compatible with wood data.

KEY WORDS: Capparales, ecological wood anatomy, glucosinolate families, Limnanthaceae, secondary xylem, Tropaeolaceae, vine anatomy.

RESUMEN

Se ofrecen datos cualitativos y cuantitativos sobre los leños de *Limnanthes douglasii* R. Brown y *Tropaeolum majus* L.; hasta ahora no existían descripciones de los leños de Limnanthaceae y Tropaeolaceae. El leño de *Limnanthes douglasii* se presenta localizado en la unión entre la raíz y el tallo. Los elementos traqueales sin perforaciones faltan completamente, y tanto el parénquima axial como el radial tienen paredes finas. *Tropaeolum majus* tiene el leño radical con elementos traqueales compuestos por vasos anchos y estrechos; y no hay fibras libriformes presentes. En los tallos existen fibras libriformes, aunque predominan en el xilema secundario formado tardíamente. Los patrones del leño de *Limnanthes* y *Tropaeolum* son característicos de una hierba anual y una trepadora respectivamente. Aunque las dos especies son herbáceas, los modelos del leño son bastante diferentes, hecho explicable tanto por el hábito como por la posición sistemática de las dos especies. Los datos del leño sostienen el concepto de que las dos familias se encuadran en un Capparales nuevo ampliado.

INTRODUCTION

No data on wood anatomy of either Limnanthaceae or Tropaeolaceae have been presented to date (Metcalf & Chalk 1950; Gregory 1994). The wood of these families is interesting with respect to their divergent kinds of habits; all members of both families are herbs. The two families are grouped here because they are the most herbaceous of the families recog-

nized among the glucosinolate families, which may be considered Capparales sensu lato, by Dahlgren (1975), Rodman (1991a, 1991b) and Rodman et al. (1993, 1994). Formerly both Limnanthaceae and Tropaeolaceae were included in Geraniales (e.g., Cronquist 1981; Thorne 1992). In some recent cladistic systems, Tropaeolaceae are a sister group to Akaniaceae and Bretschneideraceae; Limnanthaceae are not far away in the clade of Capparales (s.l.), and among the groups nearest to Limnanthaceae are Batidaceae, Caricaceae, and Moringaceae (Rodman et al. 1993, 1994). Tropaeolaceae and Limnanthaceae are placed close to Capparaceae in the cladogram of Conti et al. (1996), who include fewer of the glucosinolate families in their survey, and who therefore offer less precision in the placement of these two families.

Rodman et al. (1993) concede that marked evolutionary shift in habit must be hypothesized if Tropaeolaceae are close to the tree families Akaniaceae and Bretschneideraceae. However, they do not consider this improbable and invite consideration of how these changes may have occurred. Similar considerations apply to Limnanthaceae. The species of *Tropaeolum* studied, the well known *T. majus*, is an annual herb with vining capabilities. The base of the stem contains a cylinder of secondary xylem 1–2 mm in thickness; the upper portion of the root contains a xylem core 1–3 mm in thickness; these have been used in the present study. *Limnanthes douglasii* is less woody than *Tropaeolum*; *Limnanthes* is an annual with a short basal stem to which numerous thin roots are attached; upwardly, the basal stem branches into several prostrate stems. The patches of secondary xylem in the stem of *Limnanthes* are evidently related to these prostrate stems. These distinctive habits, and the fact that secondary xylem in Limnanthaceae and Tropaeolaceae is minimal in comparison with that of other capparalean families provide reasons for study of wood anatomy of these two families. If marked differences in habit have occurred phyletically in the divergence of these two families from their nearest neighbors, we will have new examples of how nature of wood anatomy reflects shift in habit. To be sure, only one species of each family has been used in the present study. The reason for this selection is that for each family, the species studied is the woodiest that could be obtained readily. Further studies are needed, but they may demonstrate more herbaceous modes of structure than do the species in the present paper, judging from the habits described for Limnanthaceae by Ornduff (1971) and Tropaeolaceae by Sparre et al. (1991).

MATERIALS AND METHODS

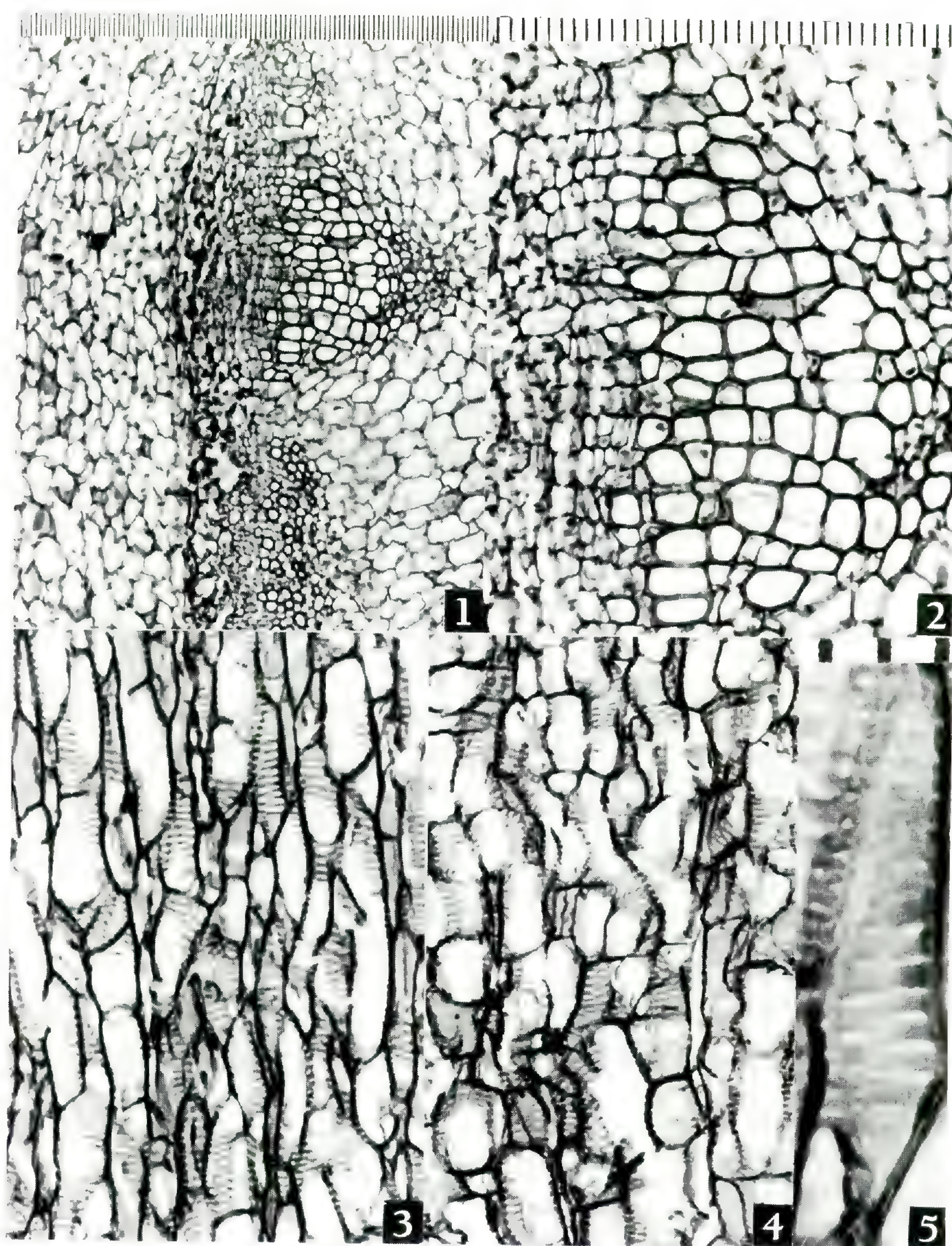
Stems and roots bearing secondary xylem from plants of *Tropaeolum majus* and *Limnanthes douglasii* that were judged to be mature but not yet in decline were collected from plants in cultivation. In the case of the *Tropaeolum*,

plants were collected from a Santa Barbara garden where the species has naturalized. Plants of *Limnanthus douglasii* were collected from Santa Barbara Botanic Garden, where they have become naturalized, with the aid of Mark Stubler. The portions bearing secondary xylem were preserved in 50% aqueous ethyl alcohol. Wood of *Tropaeolum* was softened by immersion in 5% ethylene diamine for two hours. Material was infiltrated and embedded in paraffin according to the usual techniques, sectioned on a rotary microtome; sections mounted on slides were stained with a safranin-fast green combination corresponding to Northen's modification of Foster's tannic acid-ferric chloride method (Johansen 1940). In addition, some sections of unsoftened stems of *T. majus* were sectioned on a sliding microtome, dried between glass slides, sputter coated, and examined with a scanning electron microscope (SEM). Macerations were prepared with Jeffrey's fluid and stained with safranin.

Terminology follows that of the IAWA Committee on Nomenclature (1964). The term "pseudoscalariform" refers to pitting in which pits are horizontally elongate, as in scalariform pitting, but are derived from alternate pits that are markedly widened, and thus the ends of the pits do not correspond to angles of the vessels. Vessels were measured in term of lumen diameter; if oval rather than near-circular in outline, the mean diameter was estimated. The term "intervascular" axial parenchyma refers to a situation in which occasional axial parenchyma cells are scattered among large groupings of vessels, whereas paratracheal parenchyma applies to parenchyma surrounding a vessel or vessel group.

ANATOMICAL RESULTS

Limnanthus douglasii stem (Fig. 1–5). Secondary xylem very limited in extent, and also localized in several segments within the vascular cylinder (Fig. 1, top), intervening parts of the cylinder composed of primary xylem only (e.g., Fig. 1, bottom). Vessels square or polygonal in outline, in large groupings with few intervening axial parenchyma cells (Fig. 1); mean number of vessels per group, 18.1; mean number of vessels per mm² (no areas adjacent to secondary xylem included), 690. Mean vessel diameter, 28.2 µm. Mean vessel element length, 71.6 µm. Perforation plates all simple, circular, and appreciably narrower than the vessel diameter (Fig. 4). Vessels irregular in outline, either as seen in tangential (Fig. 3) or radial (Fig. 4) sections. Lateral wall pitting of vessels consisting of pits laterally elongate, alternate to pseudoscalariform (Fig. 5). Lateral wall pits (pit cavity) about 5 µm as measured vertically (Fig. 5). Imperforate tracheary elements absent. Axial parenchyma sparse, intervascular (Fig. 2), subdivided into strands or two or not subdivided, with thin primary walls only. Rays uniseriate or biseriate (Fig. 3). Mean height of biseriate rays, 238 µm; mean height of

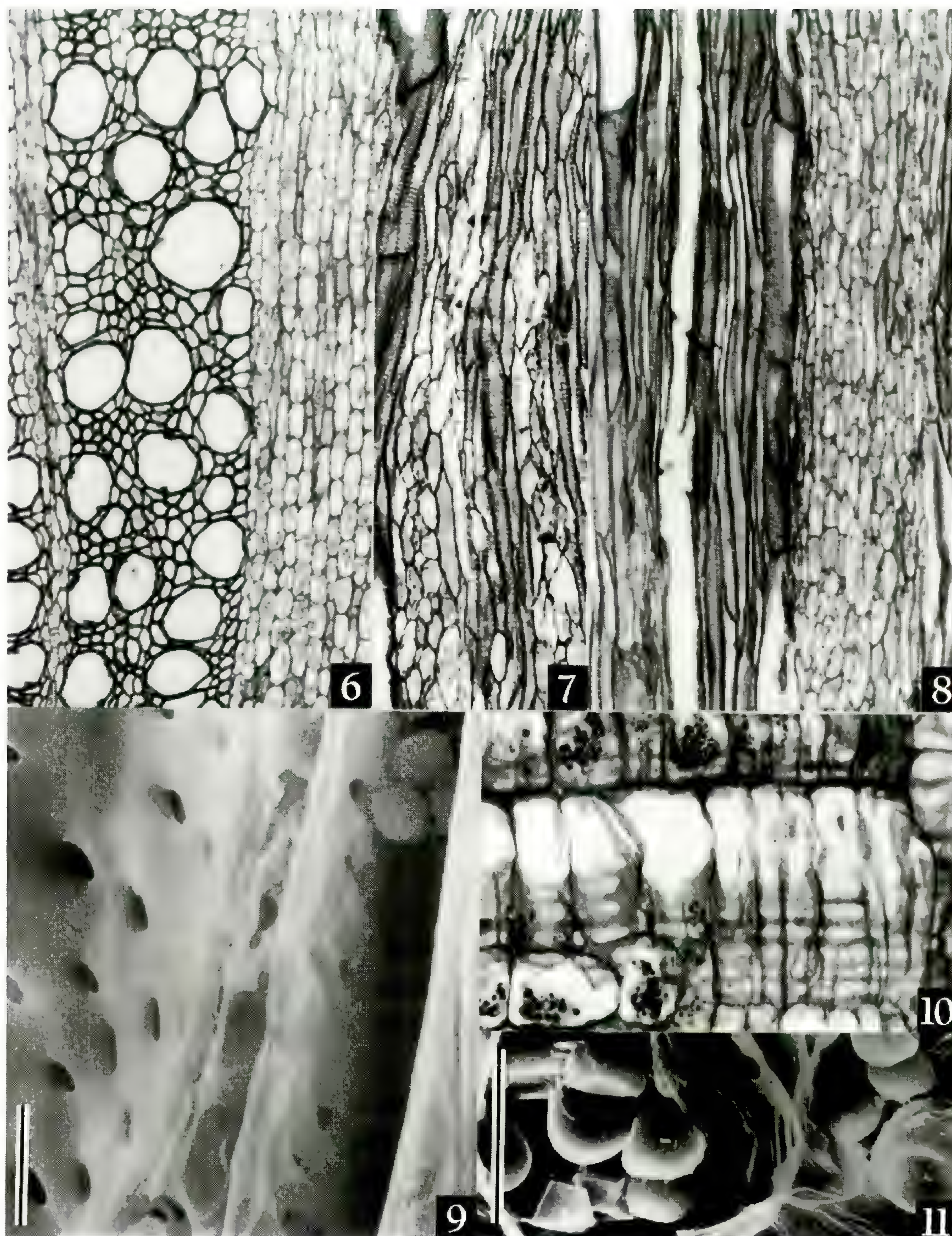


FIGS. 1–5. Wood sections of *Limnanthes douglasii* stems. Fig. 1. Transection; portion of cylinder with secondary xylem, above, portion with only primary xylem below. Fig. 2. Enlarged portion of secondary xylem to show angular nature of vessels; imperforate tracheary elements are absent. Fig. 3. Tangential section; rays are uniseriate or biseriate, composed of upright cells. Fig. 4. Radial section; shortness of vessel elements evident. Fig. 5. Vessel element from tangential section to show pseudoscalariform lateral wall pitting. Fig. 1, scale above Fig. 1 (divisions = 10 μ m); Figs. 2–4, scale above Fig. 2 (divisions = 10 μ m); Fig. 5, scale above Fig. 5 (divisions = 10 μ m).

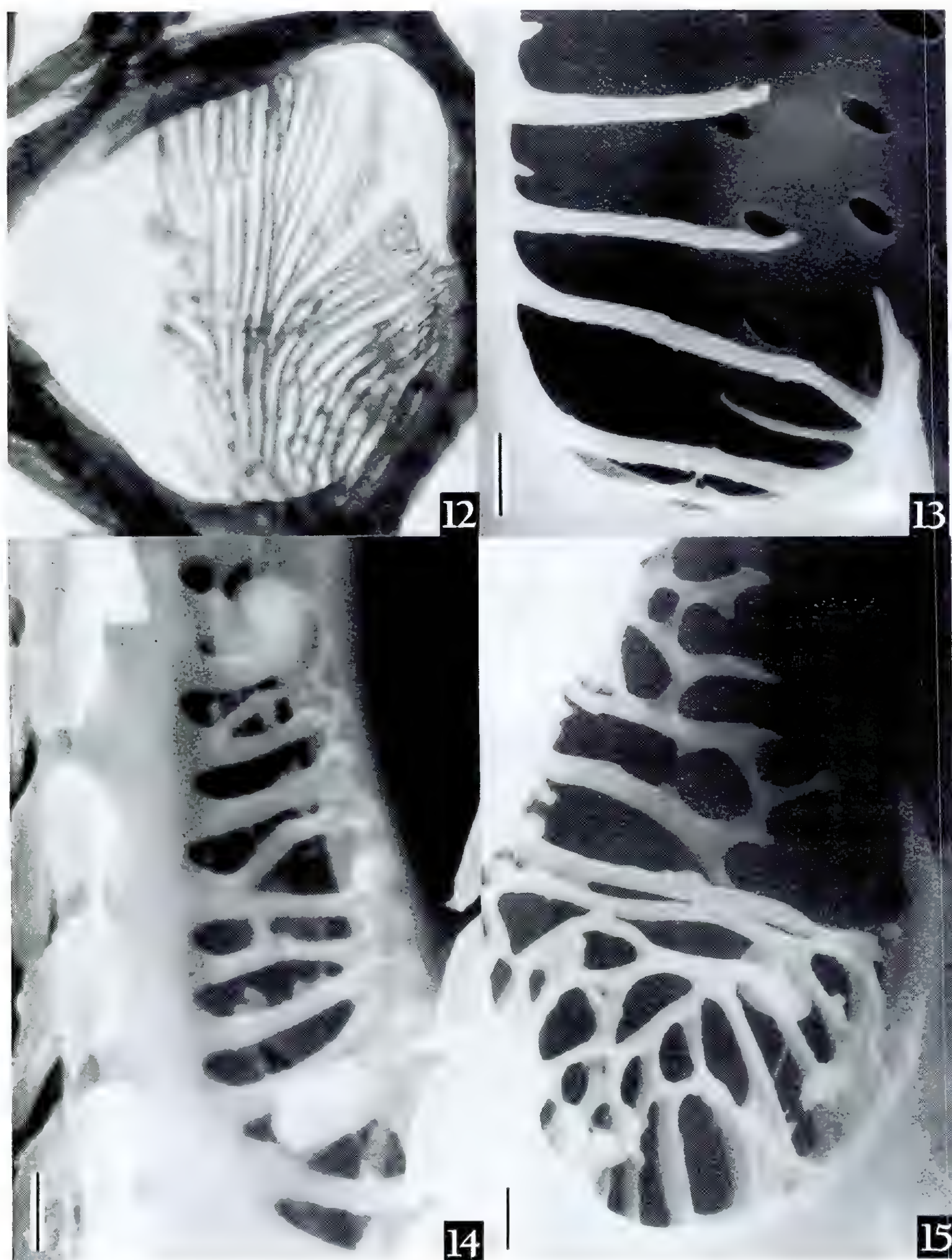
uniseriate rays, 91 μm . Ray cells with thin primary walls. Wood nonstoried (Fig. 3), no starch or crystals observed.

Tropaeolum majus stem (Fig. 6, 8–15). Axial portions of wood consisting largely of vessels dimorphic in diameter (Fig. 6). Wide vessels solitary or in pairs (mean number of vessels per group in nonray areas, 1.8), mean diameter, 81 μm . Narrow vessels comprising the bulk of the remainder of the secondary xylem and therefore in indefinitely large groups; mean diameter of the narrower vessels, 29 μm . Mean length vessel elements (wide and narrow vessel elements combined), 116 μm . Mean wall thickness of vessels varying from 1.8 μm for narrower vessels to 2.5 μm for wider vessels. Perforation plates mostly simple, but occasional scalariform or scalariformlike plates present (Fig. 12–15): some plates with numerous forked or interconnected bars (Fig. 12), some with few bars (Fig. 13), some, on narrow vessels, with wide bars (Fig. 14), some with a condition intermediate between scalariform and multiperforate (Fig. 15). Lateral wall pitting of vessels alternate, pits circular to oval (Fig. 9, left) or elliptical, about 5 μm measured vertically. Libriform fibers present, especially in earlier formed portions of secondary xylem, supplanted in later portions of axial secondary xylem by narrow vessels. Libriform fibers with simple pits, and often containing starch grains (Fig. 9, right). Mean length of libriform fibers, 462 μm ; mean diameter, 24 μm ; mean wall thickness, 2.2 μm . A few vasicentric tracheids and a few cells intermediate in pitting between libriform fibers and vasicentric tracheids present. Axial parenchyma with thin secondary walls, in strands of two cells, adjacent to the larger vessels. Rays multiseriate only, more than 1,000 μm in mean height (Fig. 8, right). Mean width of multiseriate rays, 12 cells. Ray cells with thin primary walls, bearing prominent pit fields on radial walls, separated from each other by horizontal bands of primary wall material (Fig. 10). Ray cells predominantly upright; square and procumbent cells in central portions of rays (Fig. 10). Wood nonstoried (Fig. 8). Starch abundant in ray cells (Fig. 10), starch grains spherical in shape (Fig. 11).

Tropaeolum majus, root (Fig. 7). Axial portions of wood consisting mostly of vessels dimorphic in diameter. Larger vessels mostly solitary, mean number of vessels per group, 1.4. Narrower vessels in groups of indefinite extent. Mean number of larger vessels (ray areas excluded), 44.8. Mean diameter of larger vessels, 96 μm ; mean diameter of narrower vessels, 27 μm . Mean wall thickness of vessels varying from 1.8 to 3.5 μm . Mean length of vessel elements (wide and narrow vessel elements together), 99 μm . Perforation plates and lateral wall pitting as in stems. Libriform fibers very few; a few vasicentric tracheids present. Axial parenchyma in strands of two cells, with secondary walls, adjacent to the larger vessels. Rays multiseriate and uniseriate (Fig. 7). Mean height of multiseriate rays, 1460 μm ; mean



FIGS. 6–11. *Tropacolum majus*, sections of secondary xylem from stems (Figs. 6, 8–11) and root (Fig. 7). Fig. 6. Transection; marked dimorphism in vessel diameter evident; wide ray at right. Fig. 7. Tangential section; rays narrower, shorter than those of stems. Fig. 8. Tangential section; rays are multiseriate, wide, tall. Fig. 9. SEM photograph of vessel (left) and libriform fiber (right). Fig. 10. Portion of ray from radial section; primary pit fields common on radial walls. Fig. 11. SEM photograph of ray cells from tangential section to show starch grains. Figs. 6–8, scale above Fig. 1; Fig. 10, scale above Fig. 2; Figs. 9, 11, scales at lower left (bar = 5 μ m).



FIGS. 12–15. Perforation plates from vessels of *Tropaeolum majus* stems. Fig. 12. Light micrograph of perforation plate from transection, bars numerous and narrow. Figs. 13–15. SEM photographs of perforation plates from radial section. Fig. 13. Bars few, wide. Fig. 14. Plate from narrow vessel; bars wide. Fig. 15. Plate intermediate between scalariform and multiperforate. Fig. 12, scale above Fig. 5; Figs. 13–15, bars at lower left = 5 μ m.

height of uniseriate rays, 312 μm . Ray cells mostly upright, a few square and procumbent cells present in central portions of multiseriate rays. Mean width of multiseriate rays, 5.1 cells. Ray cells thin-walled, nonlignified. Wood nonstoried, but vague storying visible in tangential sections of secondary phloem. Starch grains abundant in ray cells.

DISCUSSION AND CONCLUSIONS

Limnanthes and *Tropaeolum* differ in a number of salient ways with respect to wood anatomy. *Limnanthes douglasii* has narrow vessels angular in transection, nondimorphic in diameter, with simple perforation plates exclusively and with mostly pseudoscalariform lateral wall pitting; imperforate tracheary elements are entirely absent; axial parenchyma is sparse and with thin nonlignified walls; rays are uniseriate or biseriate, composed of upright cells. *Tropaeolum majus* has markedly dimorphic vessels; the larger are circular in transectional outline, the smaller circular to angular in outline; lateral wall pitting is mostly circular to elliptical; perforation plates are simple, but with an appreciable number of perforation plates that represent alterations of a scalariform pattern; libriform fibers with simple pits are present (somewhat less abundant than the narrow vessels), but a few vasicentric tracheids and cells intermediate between libriform fibers and vasicentric tracheids are present; axial parenchyma has thin lignified walls, is in strands of two cells, and is distributed adjacent to the larger vessels. In *T. majus*, rays are wide and exclusively multiseriate in stems in roots, rays are mostly multiseriate and less wide; ray cells are thin walled, filled with starch, and are mostly upright, but with procumbent and square cells in central ray portions.

The lack of imperforate tracheary elements in *Limnanthes* may be correlated with lack of upright stems, because libriform fibers would be expected where addition of mechanical strength is of selective value. The occurrence of secondary xylem in small restricted patches is related to the short duration of this annual, and the short stem. Secondary xylem apparently connects the branches with the basal stem, and the remainder of the basal stem contains primary xylem only. Thus, habit seems to correspond to those distinctive features. The shortness of vessel elements in *Limnanthes* is likely related to xeromorphy; short vessel elements are found in plants of habitats that dry as a season progresses (Carlquist 1966).

Tropaeolum wood is distinctive in the dimorphism of its vessel diameter, in the sparsity of libriform fibers (supplanted to a large extent by narrow vessels), and in the very wide, tall rays. These are features common in woods of vines and lianas (Carlquist 1985). The relative shortness of vessel elements in *T. majus* is likely related to the drying of soil as the plant reaches its mature size.

Other differences between the wood of *Limnanthus* and that of *Tropaeolum* seem related to phylogenetic relationships. For example, the wood of Tropaeolaceae, placed close to Akaniaceae and Bretschneideraceae (Rodman et al. 1993, 1994), shares with that pair of families a number of wood features (wood of those two families monographed by Carlquist, submitted): perforation plates simple but with an appreciable number of modified scalariform perforation plates; libriform fibers present; axial parenchyma sparse, distributed adjacent to the larger vessels (vasicentric in Akaniaceae and Bretschneideraceae); rays wide and tall, uniseriate rays few or absent (wide rays also a characteristic of vines and lianas, but absence of uniseriate rays is not characteristic of lianas).

On the other hand, some of the features of *Limnanthus* wood can be found in genera of Capparales from which it is not far removed according to the schemes of Rodman et al. (1993, 1994). For example, in Capparaceae, rays are uniseriate or biseriate, rarely multiseriate (Metcalf & Chalk 1950). The marked difference in habit between the annual *Limnanthus* and genera of Capparaceae, which are trees or shrubs, means that modifications related to habit are likely to be of overriding importance, and similarities related to phyletic relationship are likely to be few. Further studies on wood anatomy of the glucosinolate families, which may tentatively be considered a redefined Capparales, are planned so as to show the relative degrees of influence that habit and phylogenetic relationship have on similarities and differences among the component families of that order.

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NEW GEOGRAPHICAL AND MORPHOLOGICAL DATA FOR *SIDEROXYLON THORNEI* (SAPOTACEAE)

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ABSTRACT

Recent discoveries of new localities for this rare species justify documentation of its presently known range. The additional specimens show that leaves and fruits can be much larger than previously recorded. Foliar micromorphology as viewed by scanning electron microscopy demonstrates the species is distinctive and probably not derived from *S. lanuginosum* and *S. reclinatum* as formerly thought.

RESUMEN

El reciente descubrimiento de nuevas localidades de esta rara especie justifica la documentación de su rango conocido actualmente. Los especímenes adicionales muestran que las hojas y los frutos pueden ser mucho más grandes que los citados previamente. La micromorfología foliar al microscopio electrónico de barrido demuestra que esta especie es peculiar y que probablemente no es derivada de *S. lanuginosum* y *S. reclinatum* como se pensó previamente.

The buckthorns of the southeastern United States have long been known as species of *Bumelia*. Thorne's buckthorn or swamp buckthorn, *Bumelia thornei* Cronq., was described in 1949. It was identified as a species deserving Federal listing as an endangered species (Smithsonian Institution 1975) and has remained under consideration for listing ever since. Recently, Pennington (1990) made the combination *Sideroxylon thornei*; he gave convincing arguments (1991) that *Bumelia* should be considered congeneric with *Sideroxylon*.

Thorne's buckthorn was originally known from only a few counties in southwestern Georgia and was subsequently reported (Anderson 1988) nearby in Jackson County, Florida. Recent collections extend its known range into southeastern Georgia, extreme southeastern Alabama, and along the Apalachicola and Escambia rivers in Florida (Fig. 1). The following document the known range of *S. thornei* (sites identified only generally because of the species' rareness):

ALABAMA: Houston Co.: Big Creek, 15 May 1994, *J.R. McDonald* (FSU, TENN).
FLORIDA: Escambia Co.: Escambia River, 16 Sep 1984, *J.R. Burkhalter* 9597 (FSU).
Franklin Co.: Apalachicola River, 17 Nov 1995, *L.C. Anderson* 16114 (FSU); **Gulf Co.:** Apalachicola River, 17 Nov 1995, *L.C. Anderson* 16107 (FSU), *L.C. Anderson* 16108 (FSU),

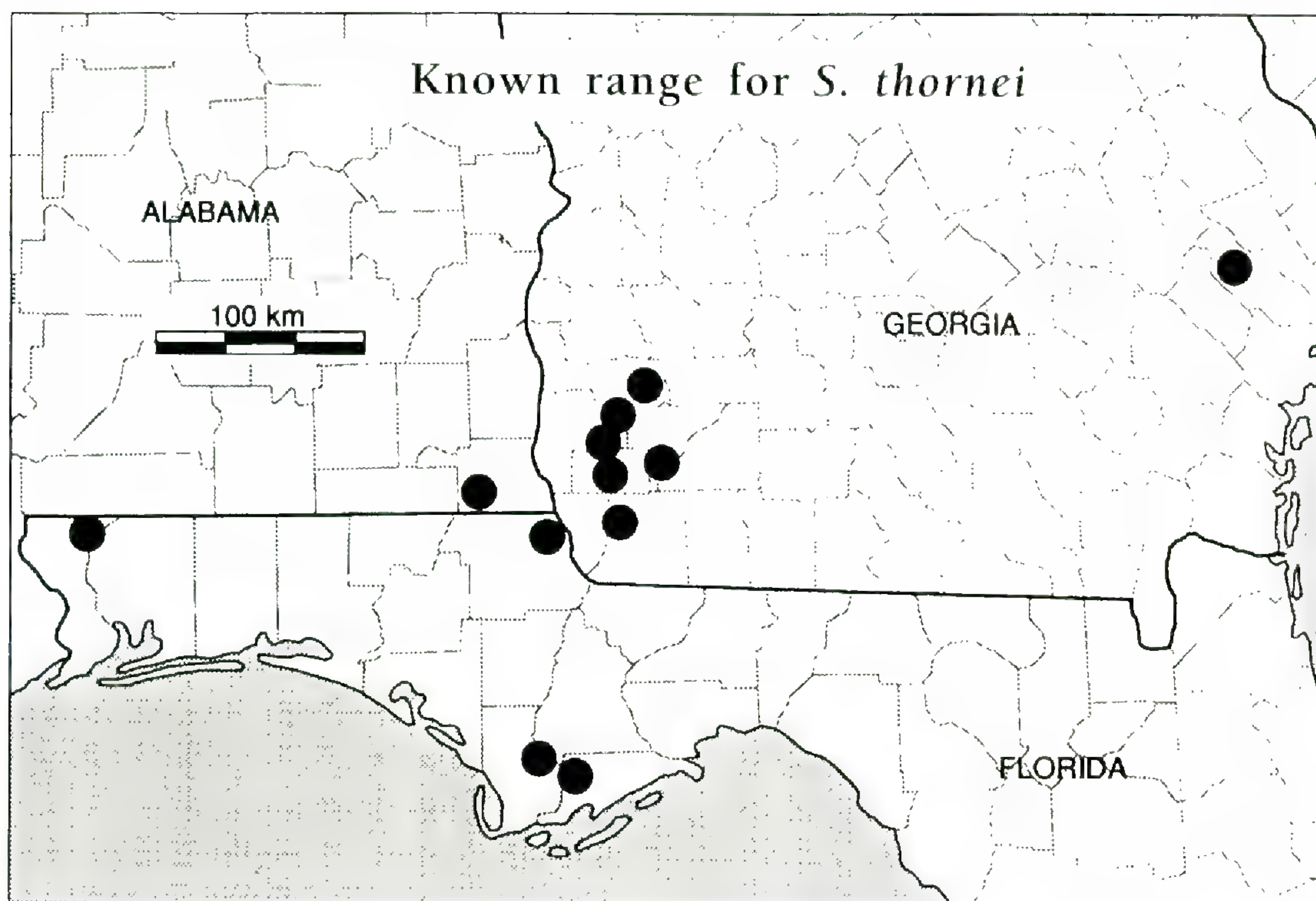


FIG. 1. Known range of *Sideroxylon thornei*.

Forbes Island, 17 Nov 1995, *L.C. Anderson* 16111 (FSU), Apalachicola River, 2 Nov 1995, *H. Light & M. Darst s.n.* (FSU). **Jackson Co.:** N of Sneads, 15 Nov 1995, *L.C. Anderson* 16082 (FSU); 11 Oct 1994, *K.C. Burks* 991 (FSU); 16 Aug 1986, *A.K. Gholson* 11720 (FLAS, FSU); 13 Jun 1988, *A.K. Gholson* 11981 (FLAS); 1 May 1982, *R.K. Godfrey* 79745 (FSU); 30 Jun 1987, *R.K. Godfrey* 82429 (FLAS, FSU, MO); 30 Jun 1987, *R.K. Godfrey* 82430 (FSU-several sheets); 27 Aug 1987, *R.K. Godfrey* 82491 (FLAS, FSU-several sheets); 20 Oct 1987, *R.K. Godfrey* 82601 (GA, FLAS, FSU); 13 Jun 1988, *R.K. Godfrey* 82691 (GA, FLAS, FSU); 18 Oct 1990, *R.K. Godfrey* 84015 (FSU, NY); N of Sneads, 19 Jun 1988, *R.B. McCartney s.n.* (GA); 13 Sep 1988, *R.B. McCartney s.n.* (FLAS). **GEORGIA:** **Baker Co.:** Flint River, 20 Oct 1995, *L.C. Anderson* 15999 (FSU); limestone pond, 3 Jun 1940, *D. Eyles* 7050 (GA); Flint River, 25 Aug 1993, *L.K. Kirkman* 3105 (Ichauway Herb.). **Calhoun Co.:** Ichawaynochaway Creek, 23 May 1990, *J.R. Allison* 4458 (GA). **Decatur Co.:** Spring Creek, 24 Oct 1990, *J.R. Allison* 5058 (GA). **Early Co.:** E of Nantz Springs, 22 May 1990, *J.R. Allison* 4446 (GA, MO); 31 Jul 1986, *A.K. Gholson* 11701 (FSU); 14 Aug 1986, *A.K. Gholson* 11713 (GA); 14 Aug 1986, *R.K. Godfrey* 82063 (GA, FLAS, FSU-several sheets, MO); 1 Oct 1986, *R.K. Godfrey* 82155 (FLAS, FSU-several sheets); 20 Oct 1992, *L.K. Kirkman* 2704 (GA, Ichauway Herb.); 13 Sep 1988, *R.B. McCartney s.n.* (FLAS); 22 Oct 1947, *R.F. Thorne* 7345 (GA-holotype, NY-isotype); Spring Creek, 24 Oct 1990, *J.R. Allison* 5052 (GA). **Liberty Co.:** Cedar Bay, 19 Aug 1993, *M.O. Moore* 1856 (GA). **Miller Co.:** Colquitt Swamp, 30 Aug 1990, *J.R. Allison* 4715 (GA).

Reports of the species from Pierce, Tattnall, and Toombs counties in Georgia were based on misidentifications; the specimens were later identified as either *S. reclinatum* Michx. or the hybrid, *S. lanuginosum* Michx. $\times$ *S. reclinatum*.

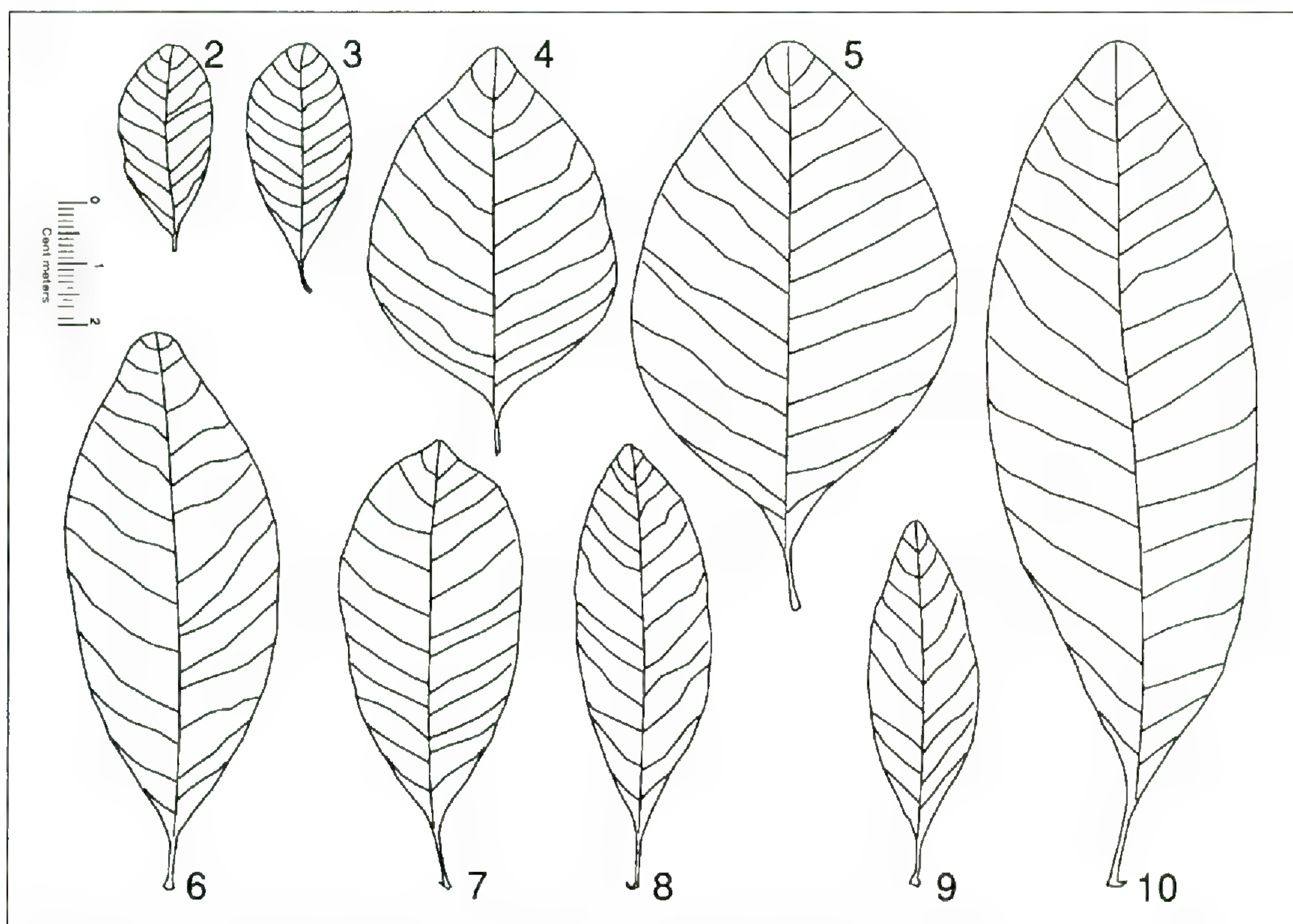
The original description (Cronquist 1949) said the species was a thorny

shrub about 1.5 m tall with mostly elliptic or elliptic oblanceolate leaves, 1.5–4 cm long and 6–20 mm wide. Godfrey's more detailed description (1988) noted the shrubs could reach 6 m in height and that leaves on a given shrub were variable in both size and shape. The variation in leaf size and shape is even greater than that recorded by Godfrey. Most leaves are oblanceolate to elliptic-oblong, but some are definitely ovate (up to 5.4 cm wide). Outlines of largest leaves from selected specimens demonstrate this variation in Figs. 2–10. The largest leaf on the holotype, *Thorne 7345*, was only 3.9 cm long (Fig. 2), whereas the largest leaf seen for the species (Fig. 10) was 13.9 cm long (*Kirkman 3105*). Part of the great size range in leaves results because some specimens were taken from the fast-growing primary canes and others from older stems that have numerous spur shoots with smaller leaves. Godfrey's population samples from the type locality show that those plants represented about 33% of the total variation found in the entire species' range in leaf size.

Cronquist (1949) noted that Thorne's buckthorn seemed to combine characteristics of *S. lanuginosum* and *S. reclinatum* and suggested it was probably of hybrid origin; that view was repeated by Pennington (1990). The key features for *S. thornei* (Godfrey 1988) include relatively glabrous stems as in *S. reclinatum* and hairy leaves more like those of *S. lanuginosum* but faintly reticulate-veined with the veins somewhat impressed (not bony cartilaginous as in *S. reclinatum*). The occurrence of larger leaves in many populations of *S. thornei* make it less similar to *S. reclinatum*.

Scanning electron microscopy of leaf surfaces was initiated to observe the dolabrate or malpighian hairs, but the form found associated with the stomata proved more interesting. All *Sideroxylon* species in the southeastern United States (seven to nine, depending on interpretation) have large stomatal rims that are raised funnel- or dome-like structures with long, narrow apertures that more or less hide the guard cells—somewhat like those illustrated for *Gordonia* (Anderson 1983). The stomatal density amongst *Sideroxylon* species appears to be inversely proportional to size of the stomatal apparatus; i.e., smaller stomates are more numerous per unit area than are larger ones (see Figs. 13 and 15).

Leaf surface micromorphology (Figs. 11–13) distinguishes *S. thornei* from all other taxa in the genus; samples from four different localities were scanned. The stomatal rims nearly cover the stomata; the rims are 14.9–17.2 μm long, and their apertures range from 0.9–1.3 μm wide. Numerous cuticular striae are aligned parallel to one another and generally at right angles to the long axes of the stomatal rims. Epidermal patterns for *S. lanuginosum* (Fig. 14), *S. reclinatum* (Fig. 16), and their putative hybrid (Fig. 15) have less pronounced stomatal rims with more open apertures, and the cuticular striae tend to encircle the rims. Stomatal rims in *S. lanuginosum*



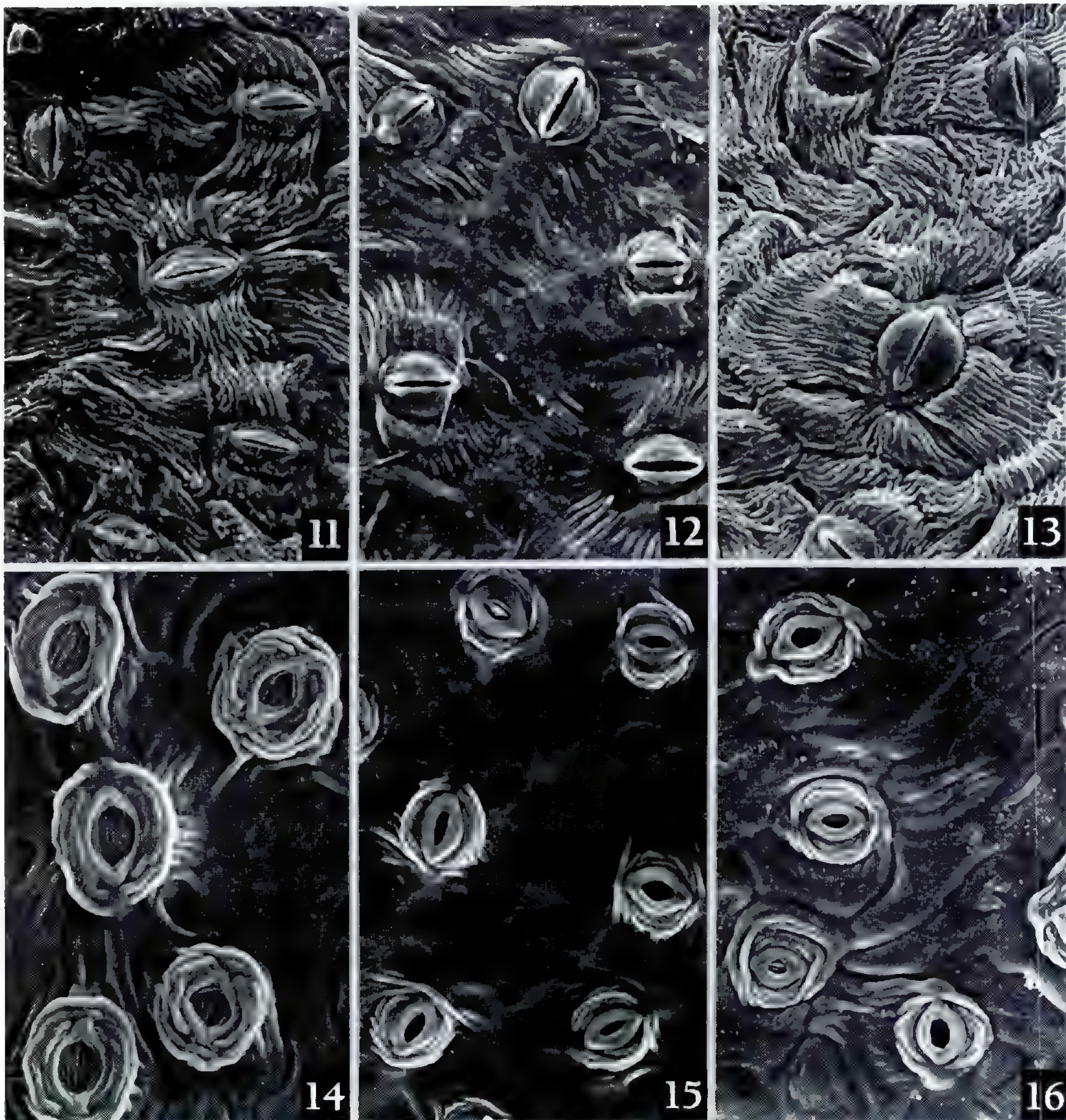
FIGS. 2–10. Largest leaf per *S. thornei* specimen to show variation in size and shape; all the same scale. Fig. 2. *Thorne* 7345, holotype. Fig. 3. *Thorne* 7345, isotype. Fig. 4. *Allison* 4715. Fig. 5. *Allison* 5058. Fig. 6. *Anderson* 11607. Fig. 7. *Anderson* 11614. Fig. 8. *Burkhalter* 9596. Fig. 9. *Moore* 1856. Fig. 10. *Kirkman* 3105.

range from 14.6–18.6 μm long, whereas they are shorter in *S. reclinatum* (12.7–13.1 μm). The surface pattern in the putative hybrid (Fig. 15) is intermediate between those of the presumed parents and supports the notion of its hybridity.

Clearly, on the basis of morphology of the stomatal complex, *S. thornei* is not derived from *S. lanuginosum* and *S. reclinatum* as some authors have suggested. The stomatal rims of *S. thornei* are most similar to those of *S. lycioides* L., but leaf surfaces of the latter have none of the cuticular striae that are so abundant in *S. thornei*.

Godfrey (1988) recorded fruit of Thorne's buckthorn as dull black, 8–10 mm long, and 8–10 mm wide, whereas fruit of *Light & Darst* (possibly more mature) was shiny black, slightly obovate, 12 mm long, and 11 mm wide.

Sideroxylon thornei is listed as endangered in Florida (Coile, 1993) and in Georgia (Patrick et al. 1995); it is a species of special concern in Alabama (Oberholster 1996). It appears to be a distinctive species in many ways. Known occurrences are still relatively few, and considerable habitat loss has been noted (Patrick et al. 1995). It deserves further field investigation of its distribution and threats and should be considered for Federal listing.



FIGS. 11–16. Scanning electron micrographs of abaxial leaf surfaces to show stomatal rims and cuticular patterns; all the same scale (scale bar in Fig. 16 = 10 μ m). Figs. 11–13. *S. thornei*, note hidden stomata and similarity of cuticular relief. Fig. 11. *Godfrey* 82063 (topotype). Fig. 12. *Anderson* 16107. Fig. 13. *Moore* 1856. Fig. 14. *S. lanuginosum*, *Anderson* 9057, note visible guard cells and numerous cuticular striae encircling the more open stomatal rims. Fig. 15. Hybrid of *S. lanuginosum* $\times$ *S. reclinatum*, *Anderson* 4858, with guard cells partially exposed and limited cuticular striae. The smaller stomatal complexes that are concomitantly more numerous per unit area may be related to hybridity. Fig. 16. *S. reclinatum*, *Godfrey* 63520, with partially open stomatal rims, cuticular striae, and minute flecks of epicuticular wax.

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MORPHOLOGICAL VARIATION AND SYNOPSIS OF THE *MUHLENBERGIA REPENS* COMPLEX (POACEAE)

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ABSTRACT

The *Muhlenbergia repens* complex consists of rhizomatous perennial species with short contracted inflorescences and awnless spikelets. A study was undertaken to determine the amount of morphological variation that is present within and among the species. Examination of morphological variation has shown that *M. plumbea* does not have a close affinity with other species of the complex. *Muhlenbergia richardsonis* and *M. squarrosa* were not found to be morphologically distinct and are considered a single highly variable species most closely related to *M. repens* and *M. utilis*. Morphological variation between *M. villiflora* and *M. villosa* intergrades to a large extent, although they remain distinct throughout most of their distribution, and they are thus recognized as a single species with two varieties, var. *villiflora* and var. *villosa*. A key to the six species and two varieties is provided.

RESUMEN

El complejo *Muhlenbergia repens* está formado por especies rizomatosas perennes con inflorescencias cortas contraídas y espiguillas místicas. Se realizó un estudio para establecer la variación morfológica intraespecífica e interespecífica. El examen de la variación morfológica ha mostrado que *M. plumbea* no tiene afinidades grandes con las otras especies del complejo. Se encontró que *Muhlenbergia richardsonis* y *M. squarrosa* no son distintas morfológicamente y son consideradas como una sola especie de variabilidad alta, más afín a *M. repens* y *M. utilis*. La variación morfológica entre *M. villiflora* y *M. villosa* se intergrada en una gran extensión aunque permanecen diferentes en la mayor parte de su distribución, y por ello se reconocen como una única especie con dos variedades, var. *villiflora* y var. *villosa*. Se ofrece una clave de las seis especies y las dos variedades.

INTRODUCTION

The genus *Muhlenbergia* Schreb., with about 160 species, has a center of distribution in the southwestern United States and northern Mexico. In general, these species are found in hot, arid habitats although some species occur in diverse situations such as moist shaded woodlands (*M. schreberi* Gmel. and its allies) and alpine meadows [*M. richardsonis* (Trin.) Rydb. and *M. filiformis* (Thurb.) Rydb.]. Members of the *Muhlenbergia repens* complex (Morden & Hatch 1987) are distributed throughout North America (excluding the southeastern United States) and in the Andean Highlands of South America. This complex is characterized by a rhizomatous perennial habit, short culms seldom exceeding 40 cm, short involute leaf blades, and a short contracted inflorescence with awnless or mucronate spikelets. As presently understood, this complex consists of eight species which may be placed into two groups based on floret vestiture. Six species are typically considered to have glabrous spikelets, several of which are minutely pubescent or scabrous on the lemma when observed closely (above 20× magnification). These include *M. repens* (Presl) Hitchc., *M. utilis* (Torr.) Hitchc., *M. richardsonis* (Trin.) Rydb., *M. squarrosa* (Trin.) Rydb., *M. fastigiata* (Presl) Henrard, and *M. plumbea* (Trin.) Hitchc. Two species, *M. villiflora* Hitchc. and *M. villosa* Swallen, have florets that are densely villous on both the lemma and palea. *Muhlenbergia plumbea*, which typically grows larger than is usual for this complex and often has an open inflorescence, is included in this complex upon the suggestion of Charlotte Reeder (pers. comm.). Most of the species occur in the southwestern United States or adjacent Mexico.

The species of the *M. repens* complex have been traditionally separated into two groups on the basis of glabrous or villous florets (Hitchcock 1950; Gould 1975). Analysis of these species using scanning electron microscopy (SEM) found that only three of the species (*M. fastigiata*, *M. plumbea*, and *M. utilis*) are completely devoid of vestiture on the floret, whereas all others have macrohairs present on the lemma and/or palea (Morden 1985). Both *M. villiflora* and *M. villosa* have copious macrohairs evident without the aid of magnification. However, *M. repens*, *M. richardsonis*, and *M. squarrosa* all have macrohairs, albeit smaller and in much lower frequency than *M. villiflora* and *M. villosa*, distributed on the lemma and palea in a pattern similar to that of the densely villous species (near the base of the lemma and between the two nerves of the palea). Of these three species, macrohairs of *M. repens* are typically longer and more densely distributed over the callus of the floret and the lemma and palea. In some populations the hairs are visible at 20× magnification with a dissecting microscope. Macrohairs of *M. richardsonis* and *M. squarrosa* are shorter and less frequent, and were seen only with SEM.

Little is known of the variation among the taxa of this complex. Morden and Hatch (1987) studied the variation present within leaf anatomical traits and found that all species of this complex were discernible with the exception of *M. richardsonis* and *M. squarrosa*. There is an apparent overlap in morphological characters and sympatry in distribution (occasionally growing side by side). In one instance, three different species of this complex were found growing within a five square meter area. Morphological characters which have often been used to separate species within this complex often show considerable variation. For example, of the species with glabrous florets, only *M. richardsonis* and *M. squarrosa* were reported to have nodulose roughening on the culms. However, upon close inspection this is found to a limited degree in all species of the complex. Further, it is not uncommon within some populations for the lower branches of the inflorescence to become relaxed, and in some cases reflexed, similar to what is found in *M. plumbea*, although most taxa typically have contracted panicles.

There are two problematic species groups within this complex. In one, *M. richardsonis* and *M. squarrosa* have been found throughout North America north of Mexico (including Alaska and the provinces of Canada) except in the southeastern United States. They have previously been reported as separate species based on culm morphology or as a single species (under *M. richardsonis*; Cronquist et al. 1977); *M. squarrosa* has stout, decumbent, and spreading culms and occupies drier sites with little competition from other species, whereas *M. richardsonis* has more slender, erect culms and is usually growing in moister soils in a meadow-like association. The South American species, *M. fastigiata*, appears similar to *M. squarrosa* and *M. richardsonis* in all characters except that the vegetative morphology is depauperate. This species occurs in the Andean Highlands of Argentina, Bolivia, and Peru, and is not found below 3000 meters elevation. Given the broad distribution of *M. richardsonis* and *M. squarrosa*, and that it often occurs at high elevations in the Rocky Mountains, one previously unexplored possibility is that *M. fastigiata* is a smaller South American form of this species. Although *M. richardsonis* and *M. squarrosa* are apparently morphologically distinct from others of the complex, they are most similar to and apparently intergrading in some regions of their range with *M. repens* (in the southwestern United States) and *M. utilis* (in Texas and California). As a result of the similar morphology herbarium specimens are frequently misidentified.

The second problematic species group includes *M. villiflora* and *M. villosa*. *Muhlenbergia villiflora* forms extensive stands across gypsiferous soils in northern Mexico and is a dominant component of that ecosystem. In contrast, *M. villosa* is found in very localized populations on alkaline and calcareous soils of western Texas and adjacent New Mexico. The nature of the rela-

tionship between these two species has not been previously explored, and the paucity of populations of *M. villosa* available for comparison (four prior to this study) has made population studies difficult.

A morphological analysis of the *M. repens* complex was undertaken to elucidate biological relationships among the species. A key and descriptions to the taxa are presented based upon population studies and results of analysis of anatomical variation (Morden & Hatch 1987).

MATERIALS AND METHODS

Field collections were made during the flowering periods of the species (August through October) in the northern states of Mexico, the southwestern United States, and the Sierra Nevada and Rocky Mountains. To insure isolation between populations, a minimum distance of 10 miles was traveled between successive collection sites. In most cases, ten independent specimens from each site were semi-randomly collected and pressed; selection was biased in favor of mature plants that did not show any signs of damage from insects, herbivores, trampling, etc. As always with rhizomatous species, the possibility exists that a population is made up of a single clone with specimens displaying mosaic or somatic variation rather than individual genetic variation. Therefore, specimens were collected far enough apart (e.g. 2 meters) within any single population to avoid this possibility. In addition, herbarium specimens on deposit in several herbaria were used to represent species we were not able to collect. In some cases, sufficient material of a single collection was available to serve as a "real" population; in other cases, "artificial" populations were made by selecting specimens from the same geographic region and grouping them together. A total of 117 populations (real and artificial) were available for analysis. Vouchers for the population study are deposited at the S.M. Tracy Herbarium (TAES).

Table 1 lists the 34 characters identified that show variation among the populations analyzed. Several characters show variations unique to this complex and warrant further description. Plants in this complex are often decumbent at the base, and as such culm height will represent culm length. Culm nodules were counted within a 5 mm distance in one surface view of the culm, generally below the inflorescence. Leaf blade curvature was recorded as a two state character and observed as straight or arcuate; degree of leaf longitudinal posture was recorded as a multistate character and recorded as flat, involute, or folded. Spikelet length was measured from the base of the spikelet to the apex of the lemma (or the glume if they exceeded the lemma) excluding the lemma awn. Occasionally, a second floret was associated with the floret, and was measured but excluded from the analysis. Vestiture of the lemma and palea was recorded as a four state character:

TABLE 1. Thirty-four characters used to access morphological variation in the *M. repens* complex. All characters were measured for continuous variation except those labeled as binary state (BS) or multistate (MS).

Vegetative: rhizome diameter, rhizome scale length, culm height, culm diameter, culm internode length, culm nodules (MS), leaf sheath length, culm/sheath ratio, ligule length, leaf blade length, leaf blade width, leaf blade curvature (BS), degree of leaf longitudinal posture (MS).
Inflorescence: inflorescence length, inflorescence width, nodes per inflorescence (MS), branches per node (MS), inflorescence branch length, inflorescence branch angle (MS), spikelets per inflorescence branch (MS), pedicel length.
Spikelet: spikelet length, first glume length, first glume nerves (MS), second glume length, second glume nerves (MS), lemma length, lemma awn length, lemma vestiture (MS), palea length, palea vestiture (MS), anther length, caryopsis length, caryopsis width.

glabrous, scabrous or minutely pubescent, with distinct trichomes (although short and/or sparse), and densely villous.

Univariate statistics (mean, standard deviation and range) were performed using SAS computer packages (Goodnight 1979). A nested analysis of variance (ANOVA) was done to compare intrapopulation, interpopulation, and interspecies variation. Multivariate statistics of principal components analysis (PCA) and cluster analysis were performed using the NT-SYS package of Rohlf et al. (1980). Principal components were derived using the correlation matrices; cluster analysis used the unweighted pair group method using arithmetic averages (UPGMA) on both correlation and distance matrices. To assess the degree of divergence among populations, the multivariate analysis of variance (MANOVA) and canonical analysis programs in SAS were used.

RESULTS AND DISCUSSION

Initially, all populations were analyzed with PCA and MANOVA to determine various groupings within the complex. Results from PCA indicated that all populations, except the nine populations of *M. plumbea*, cluster together. By analysis of eigenvector coefficients, the characters identified as contributing to the separation of these two groups were culm nodules (absent in *M. plumbea*, but present in all other species of the complex at least to a limited degree), leaf blade longitudinal posture (always folded in *M. plumbea* and flat or involute in other species), and inflorescence width. Two additional groupings were evident when all populations, excluding those of *M. plumbea*, were analyzed using PCA: populations with prominently villous florets in the spikelet were clearly separated from those with glabrous or scabrous florets. Results of an analysis of all populations using MANOVA in which the three groups just described are presented in

Figure 1. Because *M. plumbea* is so clearly distinguishable from the other species of the complex it was not considered in further population analyses. Soderstrom (1967) suggested the leaf anatomy of *M. plumbea* might be more closely related to *M. uniflora* or *M. arizonica*, a placement in which we are in agreement. Based on the results found here for all species of the complex, the remaining species will be discussed in their traditional groupings of "glabrous" taxa (macrohairs on the floret absent or not readily evident without magnification) and "villous" taxa (copious macrohairs evident without magnification).

Glabrous taxa.—Five taxa with "glabrous" florets (*M. fastigiata*, *M. repens*, *M. richardsonis*, *M. squarrosa*, and *M. utilis*, were identified in the initial analysis. An ANOVA and PCA were used to determine which characters accounted for most of the variation in distinguishing among populations. The characters identified were ligule length, spikelet length, first and second glume length, lemma length, lemma vestiture, palea length and caryopsis length. Populations of *M. richardsonis* and *M. squarrosa* are not consistently distinguishable from one another (Fig. 2) on the basis of morphological characters analyzed. This was also corroborated using cluster analysis and MANOVA (Morden 1985) and henceforth will be referred to as a single species, *M. richardsonis*. Populations of *M. utilis* and *M. repens* appear to be clearly distinguishable from those of *M. fastigiata* and *M. richardsonis* whereas populations of *M. fastigiata* and *M. richardsonis* appear to intergrade in morphological form.

To investigate this last point in more detail, analyses were performed on populations of *M. fastigiata* and *M. richardsonis* to determine the extent to which these species are similar. The results of PCA (Fig. 3) and cluster analysis (Morden 1985) clearly show these populations to be distinct. Characters which consistently distinguish these populations are plant size (culm height, internode length, and inflorescence length) and floret vestiture (*M. fastigiata* being completely glabrous whereas *M. richardsonis* is usually scabrous or minutely pubescent). Inflorescence length and floret vestiture are of particular importance because they may be indicative of a more conservative distinction between the two species, whereas differences based only on plant size may be environmentally induced.

A cluster analysis using UPGMA was performed on all four of these taxa. Characters which did not account for variation among the taxa as determined from analysis of variance and PCA were eliminated from the analysis. These results indicate that the "glabrous" taxa are represented by four distinct groups, each of which is separated from the others based on morphological characters (Fig. 4). The cluster analysis also depicts *M. richardsonis* being more closely aligned with *M. repens* rather than *M. fastigiata* as was previously hypothesized. The alignment of *M. fastigiata* and *M.*

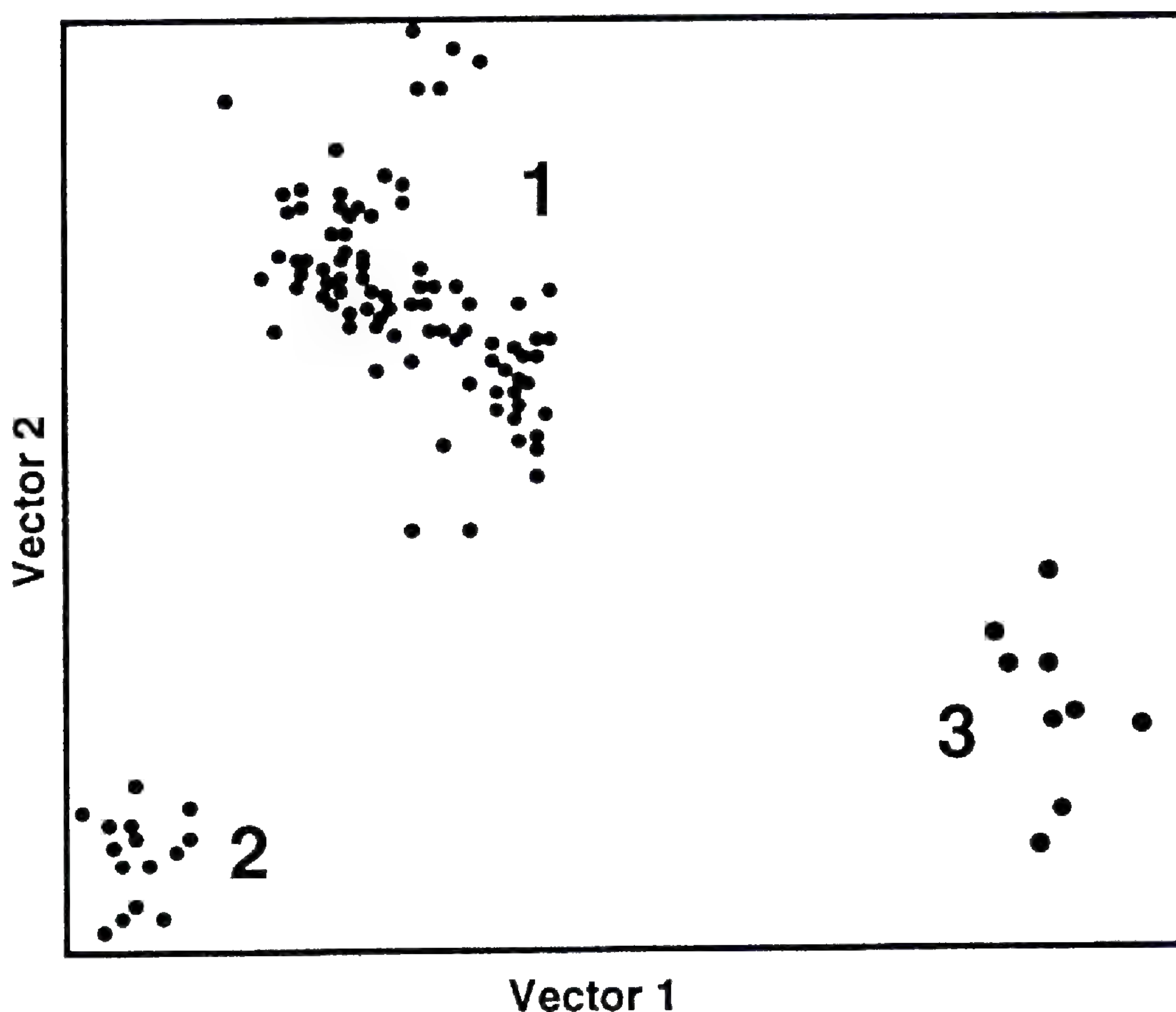


FIG. 1. Two dimensional representation of all populations of the *M. repens* complex analyzed with MANOVA. Clusters 1, 2, and 3 represent glabrous taxa, villous taxa, and *M. plumbea*, respectively.

utilis here may not be entirely unexpected; both species have completely glabrous florets and similar spikelet size, although vegetatively they are very distinct.

Villous taxa.—An ANOVA and PCA of the 15 population samples of species with distinctly villous florets, *M. villiflora* and *M. villosa*, identified ten characters for which there is relatively high level of variation at the species level. These characters were ligule length, leaf blade length, inflorescence branch length and spikelets per inflorescence branch, spikelet length, first and second glume length, lemma and palea length, and caryopsis length. The first two components in the PCA (Fig. 5) accounted for 63.4% of the variation present.

Most of the populations segregated by species classification within the plot. However, three populations of special interest include *Morden 514* ("a"; Fig. 5) *Valdes s.n.* ("b"), and *Spellenberg 4565* ("c"). Samples of *Morden 514* and *Valdes s.n.*, were collected at the same locality (Rancho Experimental "Los Angeles") in southern Coahuila during different seasons. Analysis of the specimens in *Morden 514* showed that these plants were very

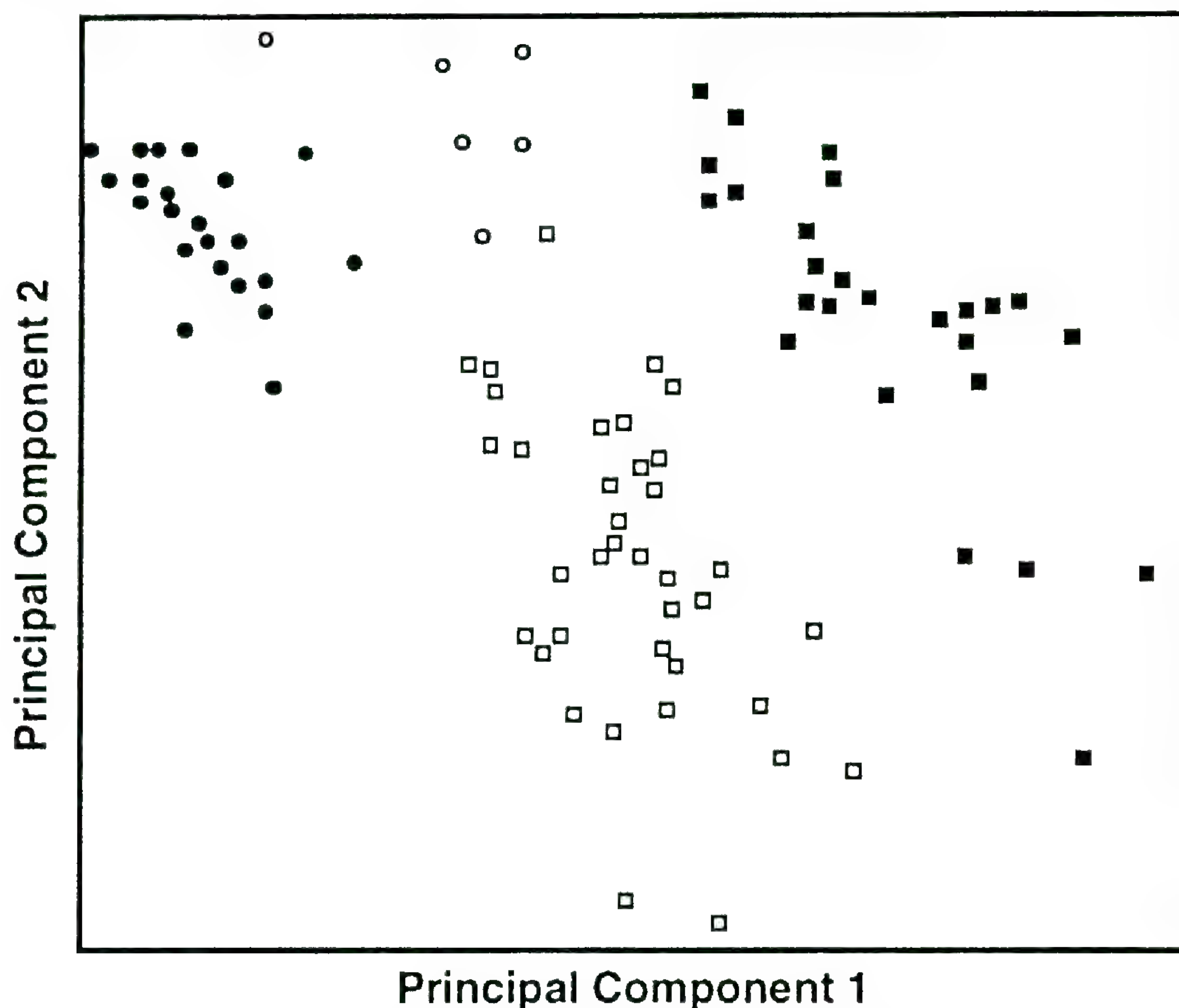


FIG. 2. Principal components analysis of populations of the "glabrous" taxa using all characters measured. The symbols present represent the species *M. repens* (■), *M. utilis* (●), *M. richardsonis* (○), and *M. fastigiata* (□). The first and second axes accounted for 53.2% of the variation.

typical of *M. villiflora* whereas those of population *Valdes s.n.* were more similar to those of *M. villosa* and clustered with them in the analysis. The distinguishing characteristic between these two species has been plant size; *M. villosa* is larger than *M. villiflora* in most morphological characters. It is evident that there exists enough plasticity in these populations that under different growing conditions the plants can exhibit the characters of the other group.

The *Spellenberg 4565* collection segregated from the rest of *M. villosa* in a way that indicated it was very distinct from other populations of this species. In analyzing individual specimens of this population, it was apparent that they represent a larger form with longer leaf blades and sheaths, longer internodes, and more nodes in the inflorescence than is typical of the species. Results of cluster analysis (Morden 1985) also show this population as segregating distinctly from the remainder of the populations.

These results support the conclusion that *M. villiflora* and *M. villosa* can not be consistently separated on the basis of morphological characters and

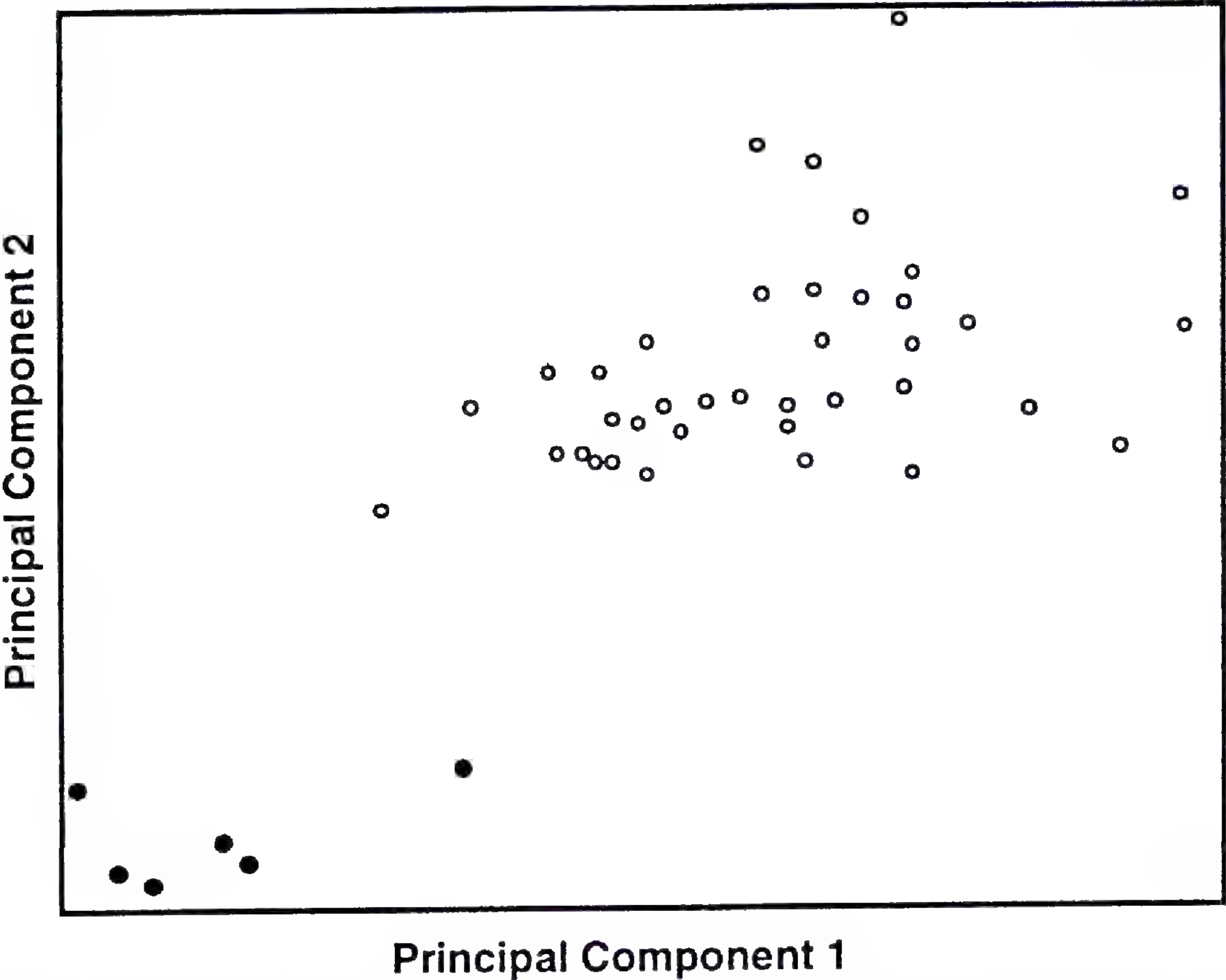


FIG. 3. Principal components analysis of populations of *M. richardsonis* (○) and *M. fastigiata* (●). The first and second axes accounted for 54.1 % of the variation.

as such should be regarded as a single species. In general, *M. villosa* tends to be larger than *M. villiflora* and occupies a different habitat (alkaline and calcareous versus gypsiferous soils, respectively). As such, they have been treated as distinct varieties under *M. villiflora* (Morden 1996). However, these differences may be a result of phenotypic variability induced by the different habitats. *Spellenberg 4565* may also represent a distinct variety that is geographically isolated from other populations. However, we refrain from taxonomic recognition of this form until more information about the population is obtained. Subsequent trips to the collection region by the first author, R. Spellenberg (New Mexico State Univ., pers. comm.), and others have failed to rediscover it, thus its true status may never be revealed.

KEY TO THE SPECIES

- 1. Inflorescence open, lower panicle branches usually greater than 5.5 cm long; leaf blades folded or flat, prominent midvein present. 2. *M. plumbea*
- 1. Inflorescence contracted, lower panicle branches usually less than 5 cm long, rarely open or reflexed; leaf blades flat or involute, a prominent midvein absent.
- 2. Lemma and palea densely villous.

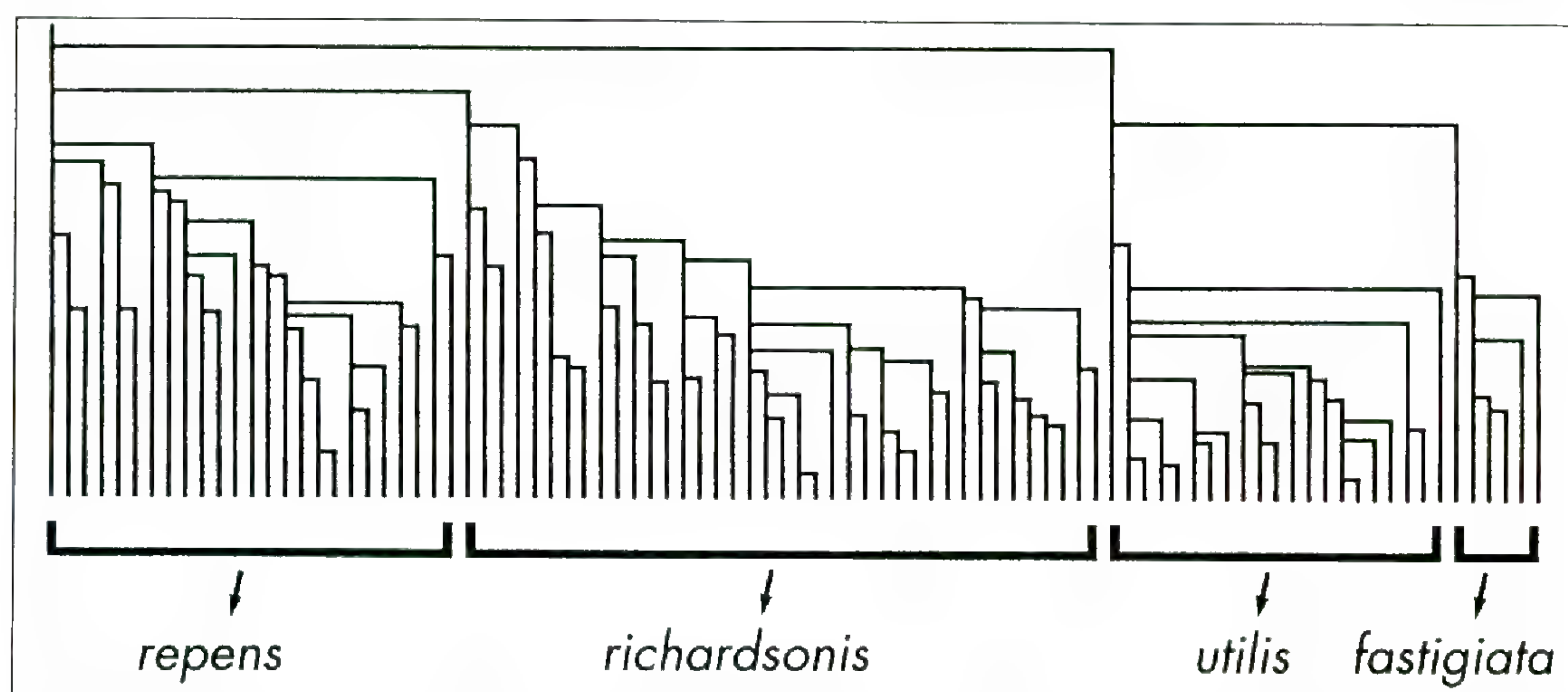


FIG. 4. Cluster analysis of the "glabrous" taxa from the distance matrix with all extraneous characters removed from the analysis.

3. Spikelets usually less than 2.0 mm long; plants of gypsiferous soils of northern Mexico 6a. *M. villiflora* var. *villiflora*
 3. Spikelets usually greater than 2.0 mm long; plants of alkaline or calcareous soils, west Texas and New Mexico 6b. *M. villiflora* var. *villosa*
 2. Lemma and palea glabrous or scabrous, not densely villous.
 4. Mature spikelets 2.7 mm long or greater; glumes greater than 1/2 the length of floret; lemma tapering to a mucro or short awn 3. *M. repens*
 4. Mature spikelets less than 2.7 mm long, seldom greater; glumes 1/2 or less than length of floret; lemma awnless or mucronate, not tapering.
 5. Ligule less than 0.6 mm long, seldom to 0.8 mm; inflorescence, at least basally, usually included in uppermost culm sheaths 5. *M. utilis*
 5. Ligule greater than 0.7 mm long, seldom less; inflorescence usually on an exserted peduncle.
 6. Plants usually less than 10 cm tall; leaves less than 9 mm long; lemma completely glabrous: Andean highlands 1. *M. fastigiata*
 6. Plants seldom less than 15 cm tall. leaves greater than 10 mm long; lemma scabrous or minutely pubescent, at least apically; North America 4. *M. richardsonis*
1. ***Muhlenbergia fastigiata*** (J. Presl) Henrard, Meded. Rijks-Herb. 40:59. 1921. BASIONYM: *Sporobolus fastigiatus* J. Presl, Rel. Haenk. 1:241. 1830. *Vilfa fastigiatus* Meyen, Reis. Erd. 1:484. 1834 (nom. nud.). TYPE: Peruviana? *Haenke s.n.* (HOLOTYPE: PR!; Type fragment: US!).

Perennial with scaly rhizomes; rhizome scales (4.5–)5.5–8.1(–10) mm long, acute, often deteriorating with age. Culms 2–8(–11) cm tall, 2–3(–5) mm diam., mostly erect, branching, glabrous; internodes 1–3(–5) mm long, compressed, nodulose-roughened slightly below inflorescence. Leaves distichous; sheaths 3–6(–8) mm long, overlapping, margins hyaline. Ligules (0.6–)0.7–1.1(–1.4) mm long, membranous, acute or slightly rounded, decurrent. Blades (2–)4–8(–9) mm long, 0.6–1.1 mm wide, involute, arcuate, glabrous, margins scabrous. Inflorescence a panicle, 1–2 cm long, 1–

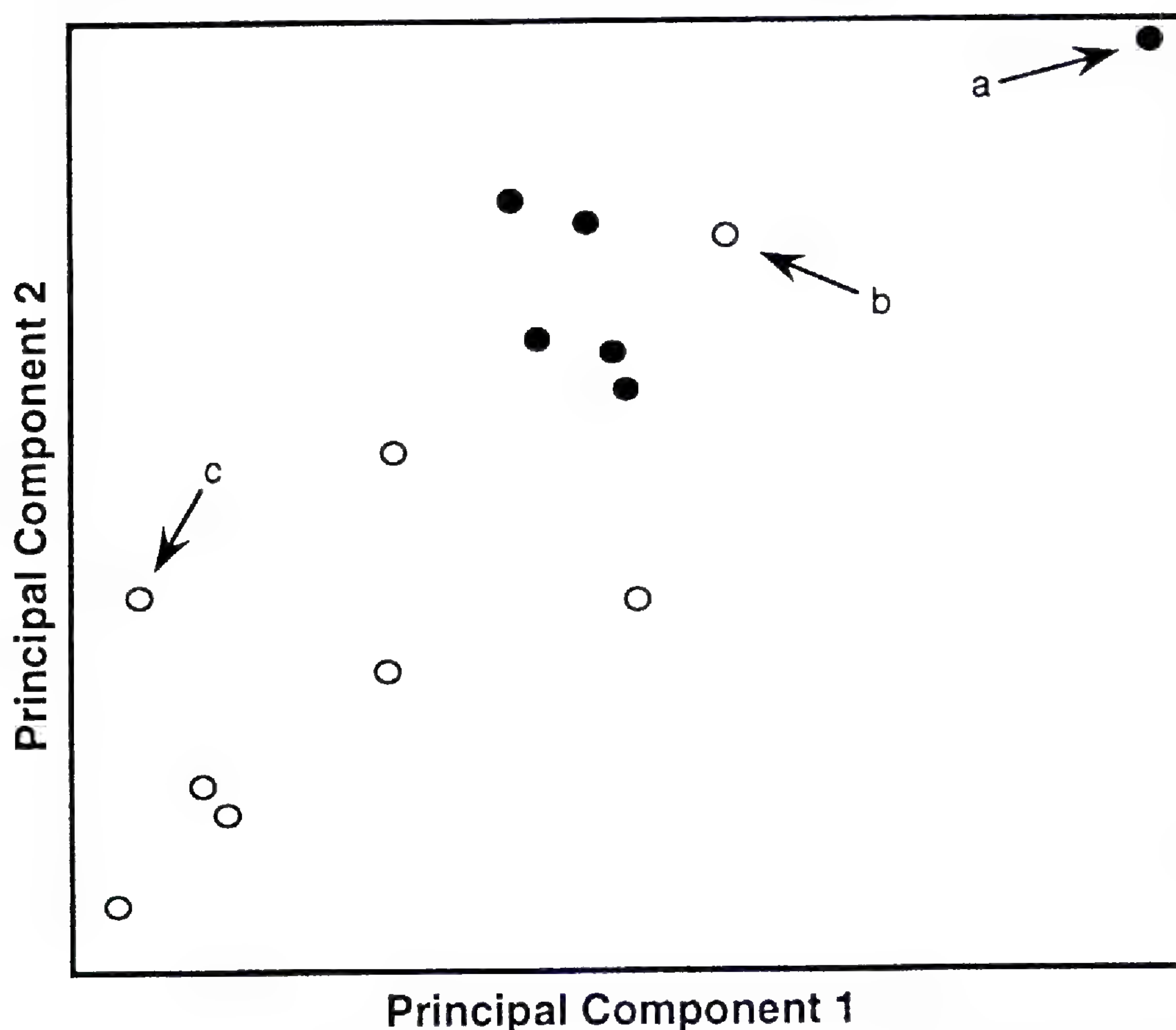


FIG. 5. Principal components analysis of the "villous" taxa, *M. villiflora* (○) and *M. villosa* (●). Populations "a" (Morden 514) and "b" (Valdes y Vasquez s.n.) were collected at the same locality (Rancho Experimental "Los Angeles", Coahuila, Mexico) in different years and growing seasons. Population "c" (Spellenberg 4565) was collected in Otero Co., New Mexico.

3(–4) mm wide, narrow, contracted usually exserted above foliage; inflorescence branches solitary at each node, with 3–7 nodes per inflorescence; branches ascending. Pedicels 0.3–0.8(–1.3) mm long, minutely setose. Spikelets (1.8–)2.0–2.4(–2.5) mm long, usually crowded on branches, 1–5(–8) spikelets on lowermost branches. Glumes (0.8–)1.0–1.4(–1.6) mm long, equal, about one-half the length of spikelet, acute, straw colored to dark green, one-nerved. Lemmas (1.7–)1.9–2.3(–2.4) mm long, 3-nerved, glabrous, narrowing to a mucronate apex, usually dark green. Paleas (1.6) 1.8–2.2(–2.4) mm long, glabrous, dark green. Anthers 0.9–1.6 mm long, yellow. Caryopses ca 1.2 mm long, 0.4 mm wide, narrowly elliptic, dark brown. Chromosome number not reported.

Distribution.—Andean highlands of Argentina, Bolivia, and Peru, usually above 3000 m elevation.

Muhlenbergia fastigiata resembles *M. richardsonis* in many of its vegetative and reproductive characteristics. However, this species differs from *M.*

richardsonis by its short stature, overlapping and distichous leaves, and florets lacking any vestiture.

2. **Muhlenbergia plumbea** (Trin.) Hitchc., Contr. U.S. Natl. Herb. 17:296. 1913. BASIONYM: *Vilfa plumbea* Trin., Mem. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt. Sci. Nat. 4(1):98. 1840. *Sporobolus plumbeus* (Trin.) Hemsl., Biol. Centr. Amer. Bot. 3:546. 1885. TYPE: "Mineral del Monte, Schlechtendal" *Schiede s.n.* (HOLOTYPE: LE!; Type fragment: US!). Herbarium labels on the type and fragment bear Schlechtendal's name, however it was probably collected by Schiede and sent to Schlechtendal, and later to Trinius.

Perennial with scaly rhizomes; rhizome scales (7.5–)8.5–13(–16) mm long, acute, often deteriorating with age. Culms 13–34(–51) cm tall, (0.4–)0.8–1.2(–1.4) mm diam., glabrous, freely branching at lower culm nodes; internodes 4–40(–60) mm long, variable, smooth, not nodulose-roughened, nodes green or purple, constricted. Sheaths (10–)15–32(–51) mm long, shorter or longer than internode, margins hyaline. Ligules 0.3–0.5(–0.7) mm long, membranous, truncate, decurrent. Blades (1.7–)3–7(–10) cm long, (1.1–)1.6–2.4(–3.0) mm wide, glabrous, flat or folded along a prominent midvein. Inflorescence a panicle, (4–)5–9(–14) cm long, 0.5–4(–8) cm wide, open, upper panicle branches ascending or reflexed, usually on a well exerted peduncle; inflorescence branches solitary at each node, with (6–)8–12(–13) nodes per inflorescence; branches usually lax, occasionally ascending, seldom appearing contracted. Pedicels (0.5–)0.7–1.3(–1.9) mm long, minutely setose. Spikelets (2.4–)2.6–3.2(–3.5) mm long, usually not appearing densely placed on branches, 3–30 spikelets per branch. Glumes (1.0–)1.2–1.6(–1.9) mm long, equal or second glume slightly longer than first, acute, $1/3$ – $1/2$ the length of the floret, usually dark green, one-nerved. Lemmas (2.2–)2.4–3.0(–3.3) mm long, rounded and tapering to an acute apex, glabrous or occasionally scabrous, dark green, 3-nerves obscure. Paleas (2.2–)2.4–2.8(–3.1) mm long, about equal to the lemma, glabrous, dark green. Anthers (1.4–)1.6–2.0(–2.1) mm long, dark green at maturity. Caryopses 1.4–1.6 mm long, 0.7–0.9 mm wide, elliptical to slightly ovate, greenish-brown. Chromosome number $2n = 40$ (Reeder 1967).

Distribution.—Valley of Mexico, and Guatemala. Moist soils in meadows, hillsides, or ditches. This species has often been misidentified as *M. richardsonis*. However, it differs by its larger spikelets, open inflorescence, and flat or folded leaf blades.

3. **Muhlenbergia repens** (J. Presl) Hitchc., In: Jepson, Fl. Calif. 1(3):111. 1912. BASIONYM: *Sporobolus repens* J. Presl, Rel. Haenk. 1:241. 1830. *Vilfa repens* (J. Presl) Trin., Mem. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt. Sci. Nat. 4(1):102. 1849. TYPE: MEXICO, *Haenke s.n.* (HOLOTYPE: PR!; Type fragment: US!; ISOTYPE: MO!).

Muhlenbergia subtilis Nees, *Linnaea* 19:689. 1847. TYPE: MEXICO, *Aschenbom* 206 (HOLOTYPE: B-lost; Type fragment: US!). *Muhlenbergia abata* I.M. Johnston, J. Arnold *Arbor.* 24:387. 1943. TYPE: NEW MEXICO. Valley of the Rio Grande, *Wright* 1982 (HOLOTYPE: GH!). Hitchcock's name of *M. repens* was incorrectly circumscribed when he transferred the name from *Sporobolus*. However, he did not explicitly exclude the type and in later publications corrected his error. Johnston provided a new name for this species assuming that Hitchcock's name was a later homonym of *Sporobolus repens* J. Presl and thus illegitimate.

Perennial with creeping, scaly rhizomes; rhizome scales (3–)5–9(–20) mm long, acute, often deteriorating with age. Culms (5–)8–20(–42) cm long, 0.3–0.6(–1.1) mm diam., decumbent and usually forming dense mats, freely branching above, glabrous; internodes 4–16(–50) mm long, variable, lightly nodulose roughened below inflorescence, usually smooth on lower culm internodes. Sheaths (2–)6–14(–34) mm long (occasionally longer), shorter to longer than internodes, margins hyaline, overlapping at base, open near collar and diverging from culm near collar. Ligules (0.1–)0.4–1.0(–1.8) mm long, membranous, truncate, decurrent, occasionally becoming split. Blades (0.4–)1.1–3.0(–6.0) cm long, (0.5–)0.7–1.5(–4) mm wide, glabrous, involute, straight or usually arcuate to spreading, midvein absent, margins scabrous. Inflorescence a panicle, 1–4(–9) cm long, 1–6(–32) mm wide, contracted, usually included at base in uppermost leaf sheath; inflorescence branches solitary at each node with (3–)4–8(–10) nodes per inflorescence; branches usually ascending, rarely lax. Pedicels (0.2–)0.5–1.5 mm long (rarely longer), minutely setose. Spikelets 2.7–3.3(–3.6) mm long (sometimes longer), usually with one floret, occasionally two, not densely distributed, 1–7(–19) spikelets usually on lowermost panicle branch. Glumes (1.1–)1.6–2.4(–3.6) mm long, about equal or first a little longer, acute, 1/2 to equaling length of floret, usually light green, 1-, 2-, or 3-nerved. Lemmas 2.6–3.2(–4.2) mm long, acute to attenuate, often narrowing into a mucro or short awn, 3-nerved, appearing glabrous or scabrous along midnerve apically, occasionally short hairs are visible near base or along margins, opaque to dark green or mottled; awn 0.1–0.3(–1.4) mm long. Paleas 2.1–2.7(–3.4) mm long, appearing glabrous or scabrous between the two nerves, color similar to lemma. Anthers (0.7–)1.0–1.4 mm long, yellow, becoming purple at maturity. Caryopses 1.1–1.5 mm long, 0.4–0.7 mm wide, elliptic to ovate, brown, usually with a straw colored coating on pericarp. Chromosome number $2n = 60$, 70–72 (Brown 1951; Morden 1985; Reeder 1967, 1968).

Distribution.—Southwestern United States and northern Mexico south through the Valley of Mexico to Chiapas. On open sandy grounds of dry meadows, canyon bottoms, and along roadsides, often forming dense stands. Soils are variable, ranging from alkaline to calcareous and heavily gypsiferous.

This species is similar to *M. utilis* in many respects, such as vegetative characteristics and the nature of the caryopsis. However, *M. utilis* can be distinguished by its smaller spikelets, more slender culms and spreading blades. Some populations tend to show intergradation with *M. richardsonis*. Vegetative apomixis in this species has been previously reported (Morden & Hatch 1986).

4. ***Muhlenbergia richardsonis*** (Trin.) Rydb., Bull. Torrey Bot. Club 32:600. 1905. BASIONYM: *Vilfa richardsonis* Trin., Mem. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt. Sci. Nat. 4(1):103. 1840. *Sporobolus richardsonis* (Trin.) Merr., Rhodora 4:46. 1902. *Muhlenbergia brevifolia* (Scribn.) Jones var. *richardsonis* (Trin.) M.E. Jones, Contr. W. Bot. 14:12. 1912. TYPE: NORTH AMERICA, *Richardson s.n.* (HOLOTYPE: LE!; Type fragment: US!).

Muhlenbergia aspericaulis Nees ex Trin., Mem. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt. Sci. Nat. 4(1):103. 1840 pro syn. *Sporobolus aspericaulis* (Nees ex Trin.) Scribn., Bot. Gaz. 21:15. 1896. TYPE: *Richardson s.n.* (HOLOTYPE: BM; Type fragment: US!). The types of the basionyms *Vilfa richardsonis* Trin. and *Muhlenbergia aspericaulis* Nees ex Trin. may be the same. *Vilfa squarrosa* Trin., Mem. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt. Sci. Nat. 4(1):100. 1840. *Muhlenbergia squarrosa* (Trin.) Rydb., Bull. Torrey Bot. Club 36:531. 1909. TYPE: Menzies Island, Columbia River, Washington, Northwest America *Douglas s.n.* (HOLOTYPE: LE!; Type fragment: US!).

Vilfa depauperata Torr. in Hook., Fl. Bor. Amer. 2:257, pl. 236. 1840. *Sporobolus depauperatus* (Torr.) Scribn., Bull. Torrey Bot. Club 9:103. 1882. TYPE: sandy parts of Columbia River, from Menzies Island upward, *Douglas s.n.* (HOLOTYPE: K; Type fragment: US!; ISOTYPE: GH!, NY!). Not *Muhlenbergia depauperata* Scribn. (Bot. Gaz. 9:187. 1884).

Perennial with scaly rhizomes, often a knotty base, mat-forming; rhizome scales (4–)6–9(–13) mm long, acute, often deteriorating with age. Culms typically (5–)10–30(–64) cm tall, occasionally taller, 0.3–0.6(–1.1) mm diam., wiry, glabrous, decumbent or erect, freely branching above or not; internodes (4–)11–40(–94) mm long, variable, variously nodulose-roughened, occasionally appearing smooth. Sheaths usually (1–)9–22(–50) mm long, shorter or longer than internode, margins hyaline, overlapping at base, open near collar and diverging from culm. Ligules (0.5–)1.0–1.9(–3.0) mm long, membranous, acute to truncate, erose, or shallowly toothed. Blades (0.4–)1.6–4.0(–6.5) cm long, (0.5–)1.0–1.6(–4.2) mm wide, flat or becoming involute when desiccated, straight or usually arcuate-spreading, midvein absent, margins scabrous. Inflorescence a panicle, (1–)2–5 cm long (rarely up to 15 cm), 1–4(–17) mm wide, contracted, usually on a well-exserted peduncle, inflorescence branches solitary at each node, (4–)7–12(–18) nodes per inflorescence; branches usually ascending, seldom lax. Pedicels (0.2–)0.5–1.1(–2.0) mm long, minutely setose. Spikelets (1.7–)2.1–2.7(–3.2) mm long, with one floret, rarely two, crowded on branches, 1–13(–40)

spikelets on lowermost panicle branch. Glumes (0.6–)0.9–1.4(–2.0) mm long, about equal or second slightly longer, acute, $1/3$ – $1/2$ the length of floret, green, 1- (rarely 2-) nerved. Lemmas (1.7–)2.0–2.6(–3.1) mm long, acute or acuminate, often mucronate, glabrous or scabrous near apex, usually dark green or mottled, 3-nerves obscure, mucro 0.1–0.2 mm long. Paleas (1.0–)1.8–2.4(–2.9) mm long, glabrous or scabrous between nerves, color similar to lemma. Anthers (0.9–)1.2–1.4(–1.6) mm long, yellow, becoming purple at maturity. Caryopses (0.9–)1.1–1.4(–1.6) mm long, 0.3–0.5(–0.6) mm wide, narrowly elliptic, brown. Chromosome number $2n = 40$ (Delay 1950; Morden 1985; Stebbins & Love 1941).

Distribution.—This is the most widely distributed species of the complex occurring from New Brunswick and Maine, west to Alaska, south through the Sierra Nevada Mountains into Baja California, and the Rocky Mountains to New Mexico and Arizona. On open soils of moist meadows or drier sites away from saturated soils, sandy arroyo bottoms, occasionally alkaline soils.

Muhlenbergia richardsonis is similar to *M. repens* with which there appears to be some intergradation in the southwestern United States. There are two intergrading forms of *M. richardsonis*. One form, which has been referred to as *M. squarrosa*, has stout, decumbent, and spreading culms and occupies drier sites with little competition from other species. The other form, referred to as *M. richardsonis*, has more slender, erect culms and is usually growing in moister soils in a meadow-like association. This species is often confused with *M. cuspidata* (Torr.) Rydb. from the Midwestern U.S., which differs by lacking rhizomes and which has puberulent culm internodes, a shorter ligule, and long glumes which are acuminate or cuspidate. *Muhlenbergia filiformis* (Thurb.) Rydb. is an annual or weak perennial resembling *M. richardsonis*, but is distinguishable by its non-nodulose roughened culms and ovate to acute glumes (these often slightly erose or ciliate along the margins).

5. *Muhlenbergia utilis* (Torr.) Hitchc., J. Wash. Acad. Sci. 23:453. 1933.

BASIONYM: *Vilfa utilis* Torr., U.S. Rep. Expl. Miss. Pacif. 5:365. 1858. *Sporobolus utilis* (Torr.) Scribn., U.S.D.A. Div. Agrostol. Bull. 17:17 1. f. 467. 1899. TYPE: Lost Mt. Spring, trip from Tejon to the Lost Hills, Calif., in stony places, Blake s.n. (HOLOTYPE: NY!; Type fragment: US!; ISOTYPES: GH!, MO!).

Vilfa sacatilla E. Fourn., Mex. Pl. 2:101. 1886. *Sporobolus sacatilla* Griseb. ex E. Fourn., Mex. Pl. 2:101. 1886 pro syn. TYPES: Chapultepec pr. Mexico, Schaffner 165 pl. ed Hohen. (W); San Luis Potosi, Virlet 1455 (P); Texas, Wright (in herb. Durand, P). (TYPE fragments: US!). Fournier (1886) also listed *Agrostis brevifolius* Nutt. as a synonym. However, this is a synonym of *Muhlenbergia cuspidata* (Torr.) Rydb.

Perennial with scaly rhizomes; rhizome scales (3–)5–9(–13) mm long,

acute; scales often deteriorating with age. Culms 7–20 cm high, 0.2–0.6(–0.9) mm diam., much branched above, erect on smaller plants, decumbent, long and trailing on larger plants, up to one meter long, usually ascending, glabrous; internodes (3–)8–22(–37) mm long, variable, lightly nodulose roughened or with siliceous markings below inflorescence, smooth or not as pronounced on lower internodes. Sheaths (3–)7–13(–24) mm long, shorter or longer than internodes, margins hyaline, overlapping at base, open near collar and diverging from culm. Ligules (0.2–)0.3–0.5(–0.8) mm long, membranous, truncate, decurrent. Blades (5–)11–24(–47) mm long, (0.2–)0.8–1.3(–1.8) mm wide, glabrous, flat or mostly involute, straight or becoming arcuate with age, blades of major culms often at right angles to culm, midvein absent, margins scabrous. Inflorescence a panicle, 1–3 cm long (rarely longer), 1–4 mm wide, contracted, usually included at base in uppermost leaf sheath; inflorescence branches solitary at each node, with 3–13 nodes per inflorescence; branches ascending, occasionally becoming lax. Pedicels (0.1–)0.2–0.6(–1.1) mm long, glabrous. Spikelets (1.4–)1.6–2.0(–2.3) mm long, with one floret, these crowded on branches, (1–)2–7(–14) spikelets on lowermost panicle branch. Glumes (0.5–)0.6–1.0(–1.4) mm long, about equal, acute, $1/3$ – $1/2$ length of floret, straw colored to light green, 1- or 3-nerved. Lemmas (1.3–)1.5–2.0(–2.3) mm long, 3-nerved, acute, not mucronate, green or purple near base at maturity, glabrous, rarely with short hairs present. Paleas (1.0–)1.4–1.8(–2.0) mm long, glabrous, color similar to lemma or with more purple at maturity. Anthers (0.7–)1.0–1.2(–1.4) mm long, yellow, becoming purple at maturity. Caryopses (0.7–)0.8–1.0(–1.2) mm long, 0.4–0.6 mm wide, elliptic to ovate, brown, usually with straw-colored coating on pericarp. Chromosome number $2n = 20$ (Gould 1966; Morden 1985).

Distribution.—United States: Arizona, southern California, Nevada, and central Texas; Mexico: Chihuahua, Coahuila, Durango, Guanajuato, Jalisco, Mexico, Nuevo Leon, Puebla, Sonora, and Veracruz; Guatamala. In wet soils, usually with slow flowing fresh water or along margins of faster flowing streams or rivers, depressions in grasslands, and alkaline or gypsiferous plains.

This species is similar to *M. repens* from which it differs by its more wiry culms, slender leaves, shorter ligules, and smaller spikelets. This species was used by people of Mexico for stuffing packsaddles, hence the common name “aparejo grass.”

6a. *Muhlenbergia villiflora* Hitchc. var. *villiflora*, see Morden 1996 (p. 29).

6b. *Muhlenbergia villiflora* Hitchc. var. *villosa* (Swallen) Morden, see Morden 1996 (pp. 29, 30).

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BOOK NOTICE

RAVEN, PETER H., RAY F. EVERT, and SUSAN E. EICHHORN. 1992. **Biology of Plants, Fifth Edition.** (ISBN 0-7901-532-2, hbk.) Worth Publishing Inc., 33 Irving Place, New York, NY 10003, (212) 475-6000, \$59.95. 791 pp.

Though not a degreed biologist by any stretch, I chose to review this book because I was initially struck by its cover. At first glance, I took it for a book on art history ... well, it is in fact an art book, but rather one on the art of Biology—a textbook on Biology to be exact. Science and art have been successfully blended here. My compliments to the designers and artists involved and to the publisher and authors who had the vision and understanding of how important exciting visuals are to the success of any publication and especially to textbooks. Knowledge is acquired so much more readily with the use of good visual material and it is not lacking here.

This is the fifth printing of this well known textbook with more full color throughout the book. Clear and more informative with new findings, chapters have been re-organized for more logical sequence. For instance, the Evolution chapter was moved to directly follow Genetics which is now in a chapter of its own. Extensive change is seen in Chapter 25 due to the many discoveries being made in plant hormones, particularly to molecular basis of hormone action, plant biotechnology and genetic engineering (recombinant DNA) technology. Boxed essays have been included in the Ecology section on the great Yellowstone Fire, on logging of ancient forests in the Pacific Northwest and competition for light in plant communities.

The fifth edition book maintains its interlocking themes of: 1) the plant body as a dynamic result of processes of growth and development carried out by chemical interactions, 2) evolutionary relationships as the guide to understanding form and function in organisms, 3) ecology as a way of emphasizing our dependence on plants to sustain our lives and those of all other living organisms.

To quote the authors ... “The fifth edition of *Biology of Plants* remains true to the book’s original goals: to present basic information about plants in an accurate, accessible, well-illustrated, and interesting way.”—*Linny Heagy*.

ANNOTATED CHECKLIST OF TREES AND SHRUBS OF ALABAMA

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ABSTRACT

A total of 72 families, 163 genera, and 443 species (including 14 represented by at least two subspecies or varieties each) are listed for Alabama. This includes 346 native and 60 naturalized species as well as 37 others believed likely to occur in the state.

RESUMEN

Se listan un total de 72 familias, 163 géneros y 443 especies (incluyendo 14 que están representadas por dos subespecies o variedades cada una) para Alabama. Se incluyen 346 especies autóctonas y 60 naturalizadas, así como otras 37 que se cree que pueden encontrarse en el estado.

INTRODUCTION

The vascular flora of Alabama is perhaps as diverse as that of any area of comparable size in the eastern United States. Although many new records for species have been obtained for Alabama in recent years, the state remains less well documented than any other based upon relative size, geological complexity, and the number of herbarium collections available for study (Holmgren et al. 1990). Much of the published material that deals directly with the Alabama flora is out-dated, out-of-print, nomenclaturally obsolete, or taxonomically inaccurate. Some of it was based (in part) upon observations that apparently remain undocumented by herbarium specimens, and so these references are equivocal if not actually misleading. Thus, even for some trees and shrubs that are aspect dominants, the identity of species in the flora of this state remains somewhat vague and uncertain.

CONTENT AND FORMAT OF THE LIST

The main reason for developing this checklist was to bring together information from various scattered sources to provide a basis for further floristic work by others as well as ourselves. Our list includes the names of all native and naturalized tree and shrub species that are known to occur

within Alabama to which were added others that seem reasonably likely to be discovered. Documentation for taxa that are listed herein as new for Alabama and for ones previously listed by Clark (1971) without county records are mainly those deposited in the Auburn University Herbarium (AUA) or the University of Alabama Herbarium (ALU/UNA). Because geographical distribution patterns often are helpful in locating additional populations, counties of occurrence are provided for newly listed and previously undocumented taxa. Some of these records, particularly for a number of the uncommon taxa, were obtained either from the computerized database at the Alabama Natural Heritage Section, Department of Conservation and Natural Resources (Anonymous 1996), or from cited references.

An all-inclusive list of every tree and shrub species of Alabama is not presently attainable simply because the flora of this state, as mentioned above, has not been as thoroughly collected as is the case for its neighbors. Some native species that are more common elsewhere and some that are naturalized or weedy may show up in Alabama and indeed be new taxa for the state, but further additions are more likely to be uncommon species that until now have not been detected. For this reason, names of several woody species from the Vascular Plant Tracking List of the Alabama Natural Heritage Section (Anonymous 1996) were included to encourage further field studies.

Three publications concerning plants of Alabama (Dean 1961; Clark 1971; Diamond & Freeman 1993) provided names for the first version of our list. On account of their content regarding the flora of Alabama, other references that deal with a broader geographical range were reviewed for additional names. These were mainly studies concerning the flora of other states (Radford et al. 1968; Coile & Jones 1985; Jones & Coile 1988; Godfrey 1988; Brown & Kirkman 1990; Wofford & Kral 1993), woody plants of the Southeast (Godfrey & Wooten 1979; 1981; Duncan & Duncan 1988; Foote & Jones 1989; Meyer et al. 1993; Luteyn et al. 1996), and comprehensive treatments for the U.S. (Little 1979; Elias 1987; Kartesz 1994).

With very few exceptions, up-to-date and currently accepted nomenclature following that of Kartesz (1994) was used throughout this list, and relevant synonymy was included. The names of plant families used herein agree with the treatment by Zomlefer (1994), which was closely adopted from Thorne (1992). Since earlier lists and much of the available taxonomic literature have employed more traditional family names, users of this list should find our inclusion and citation of alternative family names useful. Various notes were used to guide persons trying to deal with Alabama plants to taxonomic treatments in which keys helpful for determining their identity were published. We also used notes to lead readers to

references concerning other aspects of many listed species. References that were closely followed in the preparation of this list, whether published prior to or more recently than Kartesz and Zomlefer (both 1994), were also cited in the list itself to make the content more helpful to students.

Within the major classification categories used herein, the names of families, genera, species, taxa of lower rank, and their synonyms are respectively arranged in alphabetical order. Author citations for plant names follow the standardized abbreviations of Brummitt and Powell (1992). Common names were also included, either with the preferred name first or arranged in alphabetical order when no particular name was evidently "preferred," for all species and varieties for which such names were available in the literature reviewed. Bailey (1976) served as a major source for common names of naturalized non-native species and also some native taxa that have attracted the attention of horticulturists.

Both naturalized non-native species and taxa likely to occur within the state but lacking definite or recent confirmation are denoted by symbols to distinguish them from documented native species. Names of non-native species that apparently survive and reproduce outside of cultivation (by either seed or asexual means) are preceded by an asterisk (*), whereas other species that seem reasonably likely to occur in Alabama, including some undocumented or not recently collected taxa, are identified by a question mark (?) before the name. A few taxa that may long persist following cultivation (such as apple, pear, and peach) are herein listed as "naturalized" as suggested by one reviewer or more, but other woody ornamental and agricultural species that seem to be dispersed and established *only* as a result of human activities were mostly excluded in compiling this list.

Maintenance of biodiversity in commercial forests as well as in protected areas and preserves is increasingly being recognized as an important long-term objective of forest management, one that also has practical economic benefits in addition to obvious conservation goals (Hansen et al. 1991; Probst & Crow 1991; Burton et al. 1992). Since Alabama has a greater percentage (ca. 68%) of its area in forest than any other southern state (Powell et al. 1993), correct data about the woody species present in this state's ecosystems are no less than essential if sound management decisions are to be made. For this list to remain useful, it will need to be updated and upgraded from time to time so that gains in taxonomic knowledge and changes in nomenclature for these plants will be readily at hand.

LIST OF TREES AND SHRUBS

PHYLUM PINOPHYTA

(OR CONIFEROPHYTA)

GYMNOSPERMS: CONIFERS

NOTE: This phylum has been treated as the Class Gymnospermae within the Division Spermatophyta (seed plants) in traditional classification systems. Names of classes of the Pinophyta are not often used in manuals, floras, guides, etc. used for identification, but all of the members of this phylum in Alabama are now placed in the Class Pinopsida.

Cupressaceae (incl. Taxodiaceae)

NOTE: Some authors, including Kartesz (1994), treat the Taxodiaceae as distinct, but most do not.

Chamaecyparis thyoides (L.) Britton, Sterns & Poggenb. – Atlantic white-cedar, white-cedar, false cypress

Juniperus communis L. var. *depressa* Pursh – ground juniper, oldfield common juniper: Calhoun Co.

J. virginiana L. – eastern redcedar

NOTE: Plants from Alabama previously treated as *Juniperus silicicola* (Small) L.H. Bailey are regarded as *J. virginiana* (Flake et al. 1969; Adams 1986).

Taxodium distichum (L.) Rich.

var. *distichum* – baldcypress

var. *imbricarium* Nutt. – pondcypress

[*Taxodium ascendens* Brongn.]

[*Taxodium distichum* var. *nutans* (Aiton) Sweet]

Pinaceae

Pinus clausa (Chapm. ex Engelm.) Vasey ex Sarg. – sand pine

P. echinata Mill. – shortleaf pine

P. elliotii Engelm. – slash pine

P. glabra Walter – spruce pine

P. palustris Mill. – longleaf pine

[*Pinus australis* Michx.]

P. serotina Michx. – pond pine

**P. strobus* L. – eastern white pine: Lawrence, Lee, Perry, Tuscaloosa, Winston cos.

P. taeda L. – loblolly pine

P. virginiana Mill. – Virginia pine

Tsuga canadensis (L.) Carrière – eastern hemlock

PHYLUM MAGNOLIOPHYTA

(OR ANTHOPHYTA)

ANGIOSPERMS, FLOWERING PLANTS

NOTE: This phylum has been treated as the Class Angiospermae within the Division Spermatophyta in traditional classification systems.

CLASS MAGNOLIOPSIDA

DICOTYLEDONS OR DICOTS

NOTE: These plants were formerly placed in the Subclass Dicotyledoneae of the Class Angiospermae.

Aceraceae (see Sapindaceae)

Adoxaceae

NOTE: *Sambucus* and *Viburnum* have usually been treated as members of the Caprifoliaceae.

Sambucus canadensis L. – elderberry, American elder

Viburnum acerifolium L. – mapleleaf viburnum

V. bracteatum Rehder – bracted arrowwood, limerock arrowwood: Jackson, Madison cos.

V. dentatum L. var. *dentatum* – southern arrowwood

[*Viburnum semitomentosum* (Michx.) Rehder]

V. nudum L. – possumhaw viburnum

var. *cassinoides* (L.) Torr. & A. Gray

[*Viburnum cassinoides* L.]

var. *nudum*

V. obovatum Walter – small-leaf viburnum: Houston Co.

V. prunifolium L. – blackhaw

V. rafinesquianum Schult. – downy arrowwood, Rafinesque viburnum: Etowah Co.

V. rufidulum Raf. – rusty blackhaw

Anacardiaceae

Cotinus obovatus Raf. – American smoketree,
chittam-wood

[*Cotinus americanus* Nutt.]

Rhus aromatica Aiton – fragrant sumac

R. copallina L. – flameleaf sumac, shining
sumac

R. glabra L. – smooth sumac

?*R. hirta* (L.) Sudw. – staghorn sumac;
Lawrence Co.

[*Rhus typhina* L.]

R. michauxii Sarg. – false poison sumac,
Michaux's sumac

Toxicodendron pubescens Mill. – poison-oak

[*Rhus toxicodendron* L.]

[*Toxicodendron quercifolium* (Michx.)
Greene]

[*Toxicodendron toxicarium* (Salisb.) Gillis]

T. radicans (L.) Kuntze – poison-ivy

[*Rhus radicans* L.]

NOTE: Shrubby forms of poison-ivy are
commonly mistaken for poison-oak, so
the common names are often misapplied.

T. vernix (L.) Kuntze – poison-sumac

[*Rhus vernix* L.]

Annonaceae

Asimina longifolia Kral var. *spathulata* Kral
- longleaf pawpaw

A. parviflora (Michx.) Dunal – smallflower
pawpaw, dwarf pawpaw

A. triloba (L.) Dunal – pawpaw

Aquifoliaceae

Ilex ambigua (Michx.) Torr. – Carolina holly
[*Ilex caroliniana* (Walter) Trel.]

I. amelanchier M.A. Curtis in Chapm. – sarvis
(service) holly: Mobile, Washington cos.

I. cassine L. – dahoon

I. coriacea (Pursh) Chapm. – large gallberry

I. decidua Walter – possumhaw

I. glabra (L.) A. Gray – inkberry

I. longipes Chapm. ex Trel. – Georgia holly
[*Ilex decidua* var. *longipes* (Chapm. ex Trel.)
H.E. Ahles]

?*I. montana* Torr. & A. Gray – mountain
holly, winterberry

[*Ilex ambigua* var. *montana* (Torr. & A.
Gray) H.E. Ahles]

[*Ilex monticola* A. Gray]

I. myrtifolia Walter – myrtleleaf holly:
Covington, Mobile cos.

[*Ilex cassine* var. *myrtifolia* (Walter) Sarg.]

I. opaca Aiton – American holly

I. verticillata (L.) A. Gray – winterberry

I. vomitoria Aiton – yaupon

Apiaceae**(Umbelliferae; incl. Araliaceae)**

NOTE: Araliaceae has traditionally been
regarded as distinct from Apiaceae.

Aralia spinosa L. – devils-walkingstick, Her-
cules-club

Araliaceae (see Apiaceae)**Asteraceae (Compositae)**

Baccharis angustifolia Michx. – groundsel tree

B. halimifolia L. – eastern baccharis

Borrichia frutescens (L.) DC. – sea ox-eye

Chrysoma pauciflosculosa (Michx.) Greene –
beach goldenrod

[*Solidago pauciflosculosa* Michx.]

?*Iva frutescens* L. – marsh elder

I. imbricata Walter – seacoast marsh elder

Bataceae

?*Batis maritima* L. – turtleweed

Berberidaceae

Berberis canadensis Mill. – American bar-
berry: Lee Co.

**B. sargentiana* C.K. Schneid. – Sargent's
barberry: Conecuh Co.

Betulaceae

Alnus serrulata (Aiton) Willd. – hazel alder
? *Betula alleghaniensis* Britton – yellow birch

[*Betula lutea* F. Michx.]

B. lenta L. – sweet birch, cherry birch

B. nigra L. – river birch

Carpinus caroliniana Walter – American
hornbeam, ironwood

Corylus americana Walter – American hazel

C. cornuta Marshall – beaked hazel

Ostrya virginiana (Mill.) Koch – eastern
hophornbeam

Bignoniaceae

Catalpa bignonioides Walter – southern catalpa

**C. speciosa* Warder ex Engelm. – northern catalpa

Cactaceae

Opuntia humifusa (Raf.) Raf. – prickly-pear cactus

[*Opuntia compressa* J.F. Macbr.]

O. pusilla (Haw.) Nutt. – little prickly-pear

[*Opuntia drummondii* Graham]

**O. vulgaris* Mill. – common prickly-pear

Calycanthaceae

Calycanthus floridus L. – sweetshrub

var. *floridus*

var. *glaucus* (Willd.) Torr. & A. Gray

[*Calycanthus floridus* var. *laevigatus* (Willd.) Torr. & A. Gray]

Caprifoliaceae (see Adoxaceae)

Diervilla lonicera Mill. – bush-honeysuckle: Marshall Co.

D. rivularis Gatt. – streamside bush-honeysuckle

[*Diervilla sessilifolia* var. *rivularis* (Gatt.) H.E. Ahles]

D. sessilifolia Buckley – southern bush-honeysuckle

Symphoricarpos orbiculatus Moench – coralberry

Celastraceae

Euonymus americanus L. – strawberry-bush

E. atropurpureus Jacq. – eastern burningbush, wahoo

Chrysobalanaceae

NOTE: Some authors include this family within the Rosaceae.

Licania michauxii Prance – gopher-apple

[*Chrysobalanus oblongifolius* Michx.]

Clethraceae

Clethra acuminata Michx. – mountain pepperbush: Etowah Co.

C. alnifolia L. – pepperbush

[*Clethra alnifolia* var. *tomentosa* (Lam.) Michx.]

[*Clethra tomentosa* Lam.]

Clusiaceae

(Guttiferae; incl. Hypericaceae)

NOTE: Hypericaceae has traditionally been treated as a distinct family.

Hypericum brachyphyllum (Spach) Steud. – coastal plain St. Johnswort

[*Hypericum aspalathoides* Willd., in part]

H. cistifolium Lam. – roundpod St. Johnswort

H. crux-andreae (L.) Crantz – St. Peterswort

[*Hypericum stans* (Michx. ex Willd.) W.P. Adams & N. Robson]

[*Ascyrum stans* Michx. ex Willd.]

H. densiflorum Pursh – bushy St. Johnswort

H. fasciculatum Lam. – peelbark St. Johnswort

H. frondosum Michx. – cedarglade St. Johnswort

[*Hypericum aureum* Bartram]

H. galioides Lam. – bedstraw St. Johnswort

H. hypericoides (L.) Crantz – St. Andrew's cross

ssp. *hypericoides*

[*Ascyrum hypericoides* L.]

ssp. *multicaule* (Michx. ex Willd.) N. Robson

[*Hypericum stragulum* W.P. Adams & N. Robson]

H. lloydii (Svenson) W.P. Adams – Lloyd St. Johnswort, sandhill St. Johnswort: Randolph Co.

H. myrtifolium Lam. – myrtleleaf St. Johnswort

H. nitidum Lam. – Carolina St. Johnswort: Covington Co.

H. nudiflorum Michx. ex Willd. – early St. Johnswort, pretty St. Johnswort: Bibb, Choctaw, Henry, Lee, Madison, Tallapoosa cos.

H. prolificum L. – shrubby St. Johnswort

H. reductum (Svenson) W.P. Adams – Atlantic St. Johnswort: Baldwin, Covington, Escambia, Geneva, Mobile, Washington cos.

[*Hypericum aspalathoides* Willd., in part]

H. suffruticosum W.P. Adams & N. Robson
– pineland St. Johnswort
[*Ascyrum pumilum* Michx.]

Cornaceae (incl. Nyssaceae)

NOTE: Nyssaceae has traditionally been treated as distinct from Cornaceae.

Cornus alternifolia L.f. – alternateleaf dogwood

C. amomum Mill. – silky dogwood

C. asperifolia Michx. – roughleaf dogwood

C. drummondii C.A. Mey. – Drummond dogwood, roughleaf dogwood

C. florida L. – flowering dogwood

C. foemina Mill. – swamp dogwood

[*Cornus stricta* Lam.]

?*Cornus racemosa* Lam. – gray dogwood

[*Cornus foemina* ssp. *racemosa* (Lam.) J.S. Wilson]

[*Cornus paniculata* L'Hér.]

Nyssa aquatica L. – water tupelo

N. biflora Walter – swamp tupelo, blackgum
[*Nyssa sylvatica* var. *biflora* (Walter) Sarg.]

**N. ogeche* Bartram ex Marshall – Ogeechee-lime, Ogeechee-plum, Ogeechee tupelo: Barbour Co.

NOTE: This species was planted along Lake Eufaula in Eufaula National Wildlife Refuge to help stabilize eroding shoreline and to provide food for waterfowl. It is not yet proven beyond doubt to be naturalized.

N. sylvatica Marshall – blackgum, black tupelo, sourgum

Cyrillaceae

Cliftonia monophylla (Lam.) Britton ex Sarg.
– buckwheat-tree, spring titi

Cyrilla racemiflora L. – black titi, summer titi, swamp cyrilla

Ebenaceae

Diospyros virginiana L. – common persimmon

Elaeagnaceae

**Elaeagnus pungens* Thunb. – Russian olive, silverberry

**E. umbellata* Thunb. – autumn olive, autumn elaeagnus

Empetraceae

NOTE: This family is sometimes (but usually not) included in the Ericaceae (Luteyn et al. 1996).

Ceratiola ericoides Michx. – beach rosemary, sand heath

Ericaceae (see Pyrolaceae)

NOTE: We generally follow Luteyn et al. (1996) in this treatment.

?*Bejaria racemosa* Vent. – tar-flower

NOTE: This species was listed for "Ala." by Luteyn et al. (1996), but documentation is lacking at both AUA and UNA.

Epigaea repens L. – trailing arbutus

Gaylussacia baccata (Wangenh.) Koch – black huckleberry: Tuscaloosa Co.

G. dumosa (Andrews) Torr. & A. Gray – dwarf huckleberry

G. frondosa (L.) Torr. & A. Gray ex Torr. – blue huckleberry, dangleberry

G. mosieri (Small) Camp – hirsute huckleberry

G. nana (A. Gray) Small – dwarf dangleberry
[*Gaylussacia frondosa* var. *nana* A. Gray]

G. tomentosa (A. Gray) Small – dangleberry
[*Gaylussacia frondosa* var. *tomentosa* A. Gray]

Kalmia hirsuta Walter – wicky, hairy laurel

K. latifolia L. – mountain-laurel

Leucothoe axillaris (Lam.) D. Don – swamp fetterbush

L. fontanesiana (Steud.) Sleumer – dog-hobble
[*Leucothoe axillaris* var. *editorum* (Fernald & B.G. Schub.) H.E. Ahles]

[*Leucothoe editorum* Fernald & B.G. Schub.]

L. racemosa (L.) A. Gray – fetterbush

?*L. recurva* (Buckley) A. Gray – mountain fetterbush

Lyonia ligustrina (L.) DC. – male-berry

L. lucida (Lam.) Koch – fetterbush

Oxydendrum arboreum (L.) DC. – sourwood

Pieris phillyreifolia (Hook.) DC. – vine-wicky, climbing fetterbush

NOTE: Growth habit of this shrub is commonly vinelike, particularly on the bark of baldcypress.

Rhododendron alabamense Rehder – Alabama rhododendron

R. arborescens (Pursh) Torr. – smooth azalea, sweet azalea

?*R. atlanticum* (Ashe) Rehder – dwarf azalea

NOTE: A few collections from south-central Alabama were widely distributed and labeled as *R. atlanticum*. We regard those populations to be hybrid swarms of *R. alabamense* × *R. canescens*.

R. austrinum (Small) Rehder – Florida azalea, orange azalea, southern azalea

?*R. calendulaceum* (Michx.) Torr. – flame azalea

NOTE: Credited to Alabama by Luteyn et al. (1996) and others. The Alabama records seem to represent *R. cumberlandense*.

R. canescens (Michx.) Sweet – Piedmont azalea, mountain azalea, southern pinxterbloom azalea, woolly azalea

R. catawbiense Michx. – Catawba rhododendron, rosebay

R. cumberlandense E.L. Braun – Cumberland azalea, diploid flame azalea

[*Rhododendron bakeri* of Alabama authors, not (Lemmon & McKay) Hume]

?*R. maximum* L. – rosebay, great laurel

NOTE: Credited to Alabama by Luteyn et al. (1996), but documentation is lacking at AUA and UNA.

R. minus Michx. – dwarf rhododendron, rosebay

?*R. periclymenoides* (Michx.) Shinners – pinxterbloom azalea, pinxter-flower, election-pink: Clay, Crenshaw, Elmore, Lawrence, Randolph cos.

[*Rhododendron nudiflorum* (L.) Torr.]

NOTE: Considered rare in Alabama by Luteyn et al. (1996). The county records above probably represent *R. canescens*.

R. prunifolium (Small) Millais – plumleaf azalea

R. viscosum (L.) Torr.

NOTE: The varieties of this species are distinguished by habit and habitat differences that are not preserved well in herbarium specimens. Many authorities fail to recognize them because these distinctions are not evident in the material on which past taxonomic judgements were usually made.

var. *serrulatum* (Small) H.E. Ahles – hammock sweet azalea: Baldwin, Conecuh, Covington, Mobile cos.

[*Rhododendron serrulatum* (Small) Millais]

var. *viscosum* – swamp azalea: Chilton, Clay, Henry, Lee, Tuscaloosa cos.

Vaccinium arboreum Marshall – tree sparkleberry, farkleberry

V. corymbosum L. – highbush blueberry

[*Vaccinium ashei* Reade]

[*Vaccinium atrococcum* (A. Gray) A. Heller]

[*Vaccinium fuscatum* Aiton]

[*Vaccinium virgatum* Aiton]

NOTE: Vander Kloet (1980) and Luteyn et al. (1996) treated *Vaccinium ashei*, *V. atrococcum*, *V. elliotii*, *V. fuscatum*, and *V. virgatum* (*V. amoenum* Aiton) as part of the *V. corymbosum* complex. We follow Godfrey (1988) concerning these blueberries and maintain *V. elliotii* as distinct because it can easily be identified by morphological characters in the field.

?*V. crassifolium* Andrews – creeping blueberry

V. darrowii Camp – Darrow's blueberry, dull littleleaf blueberry, evergreen blueberry

V. elliotii Chapm. – Elliott's blueberry

?*V. erythrocarpum* Michx. – bearberry, mountain cranberry

NOTE: Credited to Alabama based upon its listing by Dean (1961), but documentation is lacking at AUA and UNA.

V. myrsinites Lam. – ground blueberry, shiny littleleaf blueberry

V. pallidum Aiton – hillside blueberry, low-bush blueberry, Blue Ridge blueberry

[*Vaccinium vacillans* Kalm ex Torr.]

V. stamineum L. – deerberry, squawberry

[*Vaccinium melanocarpum* C. Mohr]

[*Vaccinium stamineum* var. *melanocarpum* (C. Mohr) C. Mohr]

V. tenellum Aiton – slender blueberry, southern blueberry

Euphorbiaceae

Andrachne phyllanthoides (Nutt.) Coult. – maidenbush

Croton alabamensis E.A. Sm. ex Chapm. var. *alabamensis* – Alabama croton

**Sapium sebiferum* (L.) Roxb. – Chinese tallowtree, popcorn-tree

Sebastiania fruticosa (Bartram) Fernald – sebastian-bush

[*Sebastiania ligustrina* (Michx.) Müll.Arg.]

Stillingia aquatica Chapm. – corkwood

**Vernicia fordii* (Hemsl.) Airy-Shaw – tungoil-tree

[*Aleurites fordii* Hemsl.]

Fabaceae (Leguminosae)

NOTE: We follow Isely (1990) in this treatment.

**Albizia julibrissin* Durazz. – silk tree

Amorpha fruticosa L. – indigobush

?*A. glabra* Desf. ex Poir. – mountain indigobush

?*A. nitens* Boynton – shiny indigobush

A. schwerinii C.K. Schneid. – Schwerin's indigobush

Cercis canadensis L. – eastern redbud

Cladrastis kentukea (Dum.Cours.) Rudd – yellowwood

[*Cladrastis lutea* (F. Michx.) Koch]

**Cytisus scoparius* (L.) Link – Scotch broom

Erythrina herbacea L. – eastern coral-bean

?*Gleditsia aquatica* Marshall – waterlocust

G. triacanthos L. – honeylocust

Gymnocladus dioica (L.) Koch – Kentucky coffeetree: Madison Co.

NOTE: This species is questionably native.

**Lespedeza bicolor* Turcz. – bicolor lespedeza

**L. thunbergii* (DC.) Nakai – Thunberg lespedeza

**Parkinsonia aculeata* L. – Jerusalem-thorn

Robinia hispida L. – bristly locust

NOTE: *Robinia hispida* and other spp. of *Robinia* are very complex with many cultivated and naturalized forms that formerly were treated as species but now are probably best regarded as varieties; several of these are established and possibly naturalized in Alabama.

*var. *fertilis* (Ashe) Clausen

[*Robinia fertilis* Ashe]

*var. *hispida*

*var. *kelseyi* (Cowell ex Hutch.) Isely – Kelsey locust

[*Robinia kelseyi* Cowell ex Hutch.]

var. *nana* (Elliott) DC. – downy locust, Elliott locust

[*Robinia elliotii* (Chapm.) Ashe]

[*Robinia nana* Elliott]

*var. *rosea* Pursh

[*Robinia boyntonii* Ashe – Boynton locust]

R. pseudoacacia L. – black locust

**R. viscosa* Vent. ex Vauquelin

var. *hartwegii* (Koehne) Ashe – Hartweg locust

var. *viscosa* – clammy locust

Sesbania punicea (Cav.) Benth. – purple sesban

[*Daubentonia punicea* (Cav.) DC.]

**Wisteria floribunda* (Willd.) DC. – Japanese wisteria

NOTE: The common growth habit of *Wisteria* spp. is as a liana, but shrubby forms also occur in each of the species.

W. frutescens (L.) Poir. – American wisteria

**W. sinensis* (Sims) Sweet – Chinese wisteria

Fagaceae

Castanea dentata (Marshall) Borkh. – American chestnut

**C. mollissima* Blume – Chinese chestnut

C. pumila (L.) Mill.

var. *ozarkensis* (Ashe) Tucker – Ozark chinquapin

[*Castanea ozarkensis* Ashe]

[*Castanea alabamensis* Ashe]

var. *pumila* – Allegheny chinquapin

[*Castanea alnifolia* Nutt. – trailing chinquapin]

Fagus grandifolia Ehrh. – American beech

**Quercus acutissima* Carruth. – sawtooth oak

NOTE: *Quercus* is the largest tree or shrub genus in Alabama. Clark (1971) recognized 28 species of *Quercus*, including four with two varieties each. A number of taxa that were then considered to be conspecific are currently accepted as distinct species by many authors, and their names together with additions such as the one above account for the total of 38 *Quercus* species listed herein.

Q. alba L. – white oak

Q. arkansana Sarg. – Arkansas oak

[*Quercus caput-rivuli* Ashe]

Q. austrina Small – bluff oak, bastard white oak

[*Quercus durandii* var. *austrina* (Small) E.J. Palmer]

- Q. bicolor* Willd. – swamp white oak
Q. boyntonii Beadle – running post oak, Boynton oak: Bibb, Etowah, Shelby cos.
Q. chapmanii Sarg. – Chapman oak
Q. coccinea Münchh. – scarlet oak
Q. falcata Michx. – southern red oak
Q. geminata Small – sand live oak
 [*Quercus virginiana* var. *geminata* (Small) Sarg.]
 [*Quercus virginiana* var. *maritima* of authors, not (Michx.) C.H. Müll.]
Q. georgiana M.A. Curtis – Georgia oak: Chambers, St. Clair cos.
Q. hemisphaerica Bartram ex Willd.
 var. *hemisphaerica* – Darlington oak
 var. *maritima* (Michx.) C.H. Müll. – coast live oak
 [*Quercus maritima* (Michx.) Willd.]
 [*Quercus virginiana* var. *maritima* (Michx.) C.H. Müll.]
Q. imbricaria Michx. – shingle oak
Q. incana Bartram – bluejack oak
 [*Quercus cinerea* Michx.]
Q. laevis Walter – turkey oak
 [*Quercus catesbaei* Michx.]
Q. laurifolia Michx. – laurel oak
 [*Quercus obtusa* (Willd.) Ashe]
Q. lyrata Walter – overcup oak, swamp white oak
Q. macrocarpa Michx. – bur oak, mossy-cup oak: Montgomery, Pickens cos.
Q. margaretta Ashe ex Small – sand post oak
 NOTE: Kartesz (1994) used *Quercus margarettiae*, but Ashe's original spelling is accepted here.
 [*Quercus stellata* var. *margaretta* (Ashe ex Small) Sarg.]
Q. marilandica Münchh. – blackjack oak
Q. michauxii Nutt. – swamp chestnut oak, basket oak
Q. minima (Sarg.) Small – dwarf live oak: Baldwin Co.
Q. muehlenbergii Engelm. – chinquapin oak
 [*Quercus prinoides* var. *acuminata* (Michx.) Gleason]
Q. myrtifolia Willd. – myrtle oak
Q. nigra L. – water oak
Q. pagoda Raf. – cherrybark oak
 [*Quercus falcata* var. *pagodifolia* Elliott]
 [*Quercus pagodifolia* (Elliott) Ashe]
?Q. palustris Münchh. – pin oak
Q. phellos L. – willow oak
Q. prinoides Willd. – dwarf chinquapin oak
Q. prinus L. – chestnut oak
 [*Quercus montana* Willd.]
Q. pumila Walter – running oak
Q. rubra L. – northern red oak
 var. *ambigua* (A. Gray) Fernald
 [*Quercus borealis* F. Michx.]
 var. *rubra*
 [*Quercus maxima* (Marshall) Ashe]
Q. shumardii Buckley – Shumard oak
Q. sinuata Walter – shallow-lobed oak, bastard oak
 var. *breviloba* (Torr.) C.H. Müll. – white shin oak
 [*Quercus breviloba* (Torr.) Sarg.]
 [*Quercus durandii* var. *breviloba* (Torr.) E.J. Palmer]
 var. *sinuata* – Durand white oak: Dallas Co.
 [*Quercus durandii* Buckley var. *durandii*]
Q. stellata Wangenh. – post oak
Q. texana Buckley – Texas oak, Nuttall oak
 [*Quercus nuttallii* E.J. Palmer]
Q. velutina Lam. – black oak
Q. virginiana Mill. – live oak

Grossulariaceae

NOTE: *Itea* and *Ribes* have traditionally been placed in the Saxifragaceae.

- Itea virginica* L. – Virginia willow
Ribes curvatum Small – granite gooseberry
R. cynosbati L. – dogberry, prickly gooseberry

Hamamelidaceae

- Fothergilla gardenii* Murray – dwarf witch-alder
F. major (Sims) Lodd. – witch-alder
Hamamelis virginiana L. – witch-hazel
Liquidambar styraciflua L. – sweetgum

Hippocastanaceae

(see Sapindaceae)

Hydrangeaceae

NOTE: *Hydrangea* and *Philadelphus* have traditionally been placed in the Saxifragaceae.

Hydrangea arborescens L. – wild hydrangea,
smooth hydrangea

H. cinerea Small

[*Hydrangea arborescens* ssp. *discolor* (Ser. ex DC.) E.M. McClint.]

H. quercifolia Bartram – oakleaf hydrangea

Philadelphus hirsutus Nutt. – hairy mock-orange

P. inodorus L. – mock-orange

?*P. pubescens* Loisel. – hoary mock-orange

Hypericaceae (see Clusiaceae)

Illiciaceae

NOTE: Some authors place *Illicium* within the Magnoliaceae.

Illicium floridanum J. Ellis – Florida anise-tree

Juglandaceae

Carya alba (L.) Nutt. ex Elliott – mockernut hickory

[*Carya tomentosa* (Lam. ex Poir.) Nutt.]

C. aquatica (F. Michx.) Nutt. – water hickory

[*Juglans aquatica* F. Michx.]

C. carolinae-septentrionalis (Ashe) Engl. & Graebn. – Carolina hickory, southern shagbark hickory

[*Carya ovata* var. *australis* (Ashe) Little]

C. cordiformis (Wangenh.) Koch – bitternut hickory

C. glabra (Mill.) Sweet

var. *glabra* – pignut hickory

var. *hirsuta* (Ashe) Ashe – swamp hickory

[*Carya leiodermis* Sarg.]

**C. illinoensis* (Wangenh.) Koch – pecan

[*Carya pecan* (Marshall) Engl. & Graebn.]

C. laciniosa (F. Michx.) Loudon – shellbark hickory

C. myristiciformis (F. Michx.) Nutt. – nutmeg hickory

C. ovalis (Wangenh.) Sarg. – red hickory, sweet pignut hickory

[*Carya glabra* var. *odorata* (Marshall) Little]

C. ovata (Mill.) Koch – shagbark hickory

C. pallida (Ashe) Engl. & Graebn. – sand hickory

Juglans cinerea L. – butternut, white walnut

J. nigra L. – black walnut

Lamiaceae (Labiatae)

Calamintha coccinea (Nutt. ex Hook.) Benth.
– red basil

[*Clinopodium coccineum* (Nutt. ex Hook.) Kuntze]

[*Satureja coccinea* (Nutt. ex Hook.) Bertol.]

C. georgiana (R.M. Harper) Shinnery – Georgia basil

[*Clinopodium georgianum* R.M. Harper]

[*Satureja georgiana* (R.M. Harper) H.E. Ahles]

Conradina canescens (Torr. & A. Gray) A. Gray
– false rosemary, wild rosemary

Lauraceae

Lindera benzoin (L.) Blume – spicebush

?*L. melissifolia* (Walter) Blume – hairy spicebush

NOTE: Probably extirpated from Alabama. The only record is one from Wilcox County in 1840 (Freeman et al. 1979).

L. subcoriacea B.E. Wofford – pondberry: Mobile Co.

?*Litsea aestivalis* (L.) Fernald – pond-spice

Persea borbonia (L.) Spreng. – redbay

P. palustris (Raf.) Sarg. – swamp redbay, swampbay: Baldwin, Crenshaw, Dale, Escambia, Geneva, Mobile, Pike cos.

[*Persea borbonia* var. *pubescens* (Pursh) Little]

Sassafras albidum (Nutt.) Nees – sassafras

Leitneriaceae

?*Leitneria floridana* Chapm. – corkwood

Loganiaceae

**Buddleja lindleyana* Fortune ex Lindl. – butterfly bush

Loranthaceae

Phoradendron leucocarpum (Raf.) Reveal & M.C. Johnst. – mistletoe

[*Phoradendron serotinum* (Raf.) M.C. Johnst.]

Lythraceae

Decodon verticillatus (L.) Elliott – swamp loosestrife

**Lagerstroemia indica* L. – crapemyrtle

Magnoliaceae (see Illiciaceae)

- Liriodendron tulipifera* L. – yellow-poplar
Magnolia acuminata L. – cucumbertree
 [*Magnolia cordata* Michx.]
M. grandiflora L. – southern magnolia
M. macrophylla Michx. – bigleaf magnolia
M. pyramidata Bartram – pyramid magnolia
 [*Magnolia fraseri* var. *pyramidata* (Bartram) Pamp.]
M. tripetala L. – umbrella magnolia
M. virginiana L. – sweetbay

Malvaceae

- **Hibiscus syriacus* L. – rose-of-Sharon

Meliaceae

- **Melia azedarach* L. – Chinaberry

Moraceae (see Urticaceae)**Myricaceae**

NOTE: The nomenclature and taxonomic treatment for Myricaceae follows Wilbur (1994).

- ?*Comptonia peregrina* (L.) Coult. – sweet fern
Morella caroliniensis (Mill.) Small – evergreen bayberry
 [*Myrica heterophylla* Raf.]
M. cerifera (L.) Small – southern bayberry, waxmyrtle
 [*Myrica cerifera* L.]
 [*Myrica cerifera* var. *pumila* (Michx.) Small]
M. inodora (Bartram) Small – odorless bayberry
 [*Myrica inodora* Bartram]

Nyssaceae (see Cornaceae)**Oleaceae**

- Chionanthus virginicus* L. – fringetree, grandsir graybeard
Forestiera acuminata (Michx.) Poir. – swamp-privet
F. ligustrina (Michx.) Poir. – upland swamp-privet
Fraxinus americana L. – American ash, white ash
 [*Fraxinus biltmoreana* Beadle]

- F. caroliniana* Mill. – Carolina ash, pop ash
 [*Fraxinus pauciflora* Nutt.]
F. pennsylvanica Marshall – green ash, red ash
 [*Fraxinus lanceolata* Borkh.]
F. profunda (Bush) Bush – pumpkin ash: Cullman, Madison cos.
 [*Fraxinus tomentosa* F. Michx.]
F. quadrangulata Michx. – blue ash
 **Ligustrum japonicum* Thunb. – Japanese privet
 **L. sinense* Lour. – Chinese privet
Osmanthus americanus (L.) Benth. & Hook.f.
 ex A. Gray – devilwood

Platanaceae

- Platanus occidentalis* L. – American sycamore

Polygonaceae

- Polygonella americana* (Fisch. & C.A. Mey.) Small – southern jointweed
P. macrophylla Small – largeleaf jointweed: Baldwin Co.
P. polygama (Vent.) Engelm. & A. Gray – jointweed
 [*Polygonella croomii* Chapm.]

Pyrolaceae

NOTE: Members of the genus *Chimaphila* are subshrubs that have traditionally been placed in the Ericaceae. *Gaultheria*, *Epigaea* (both Ericaceae) and *Chimaphila* all share similar growth form and evergreen foliage, but both *Gaultheria* and *Epigaea* are more commonly treated as shrubs than *Chimaphila*.

- Chimaphila maculata* (L.) Pursh – spotted wintergreen, pipsissewa

Ranunculaceae

- Xanthorhiza simplicissima* Marshall – yellowroot

Rhamnaceae

- Ceanothus americanus* L. – New Jersey tea
C. microphyllus Michx. – littleleaf redroot, littleleaf whitethorn
Rhamnus caroliniana Walter – Carolina buckthorn
R. lanceolata Pursh – lanceleaf buckthorn

?*Sageretia minutiflora* (Michx.) Trel. – calciphile buckthorn

NOTE: The only record for Alabama is a 1950 collection from Mobile Co.

**Ziziphus jujuba* Mill. – common jujube

Rosaceae (see Chrysobalanaceae)

Amelanchier arborea (F. Michx.) Fernald var. *alabamensis* (Britton) G.N. Jones – Alabama serviceberry, Alabama shadbush

A. canadensis (L.) Medik. – thicket serviceberry

?*A. obovalis* (Michx.) Ashe – coastal plain serviceberry, shadbush

NOTE: Credited to Alabama by Dean (1961) and others, but collections of this species are lacking at AUA and UNA.

Aronia arbutifolia (L.) Pers. – red chokeberry
[*Pyrus arbutifolia* (L.) L.f.]

[*Sorbus arbutifolia* (L.) Heynh.]

Crataegus aestivalis (Walter) Torr. & A. Gray – apple haw, May hawthorn

C. brachyacantha Sarg. & Engelm. – blueberry hawthorn

C. chrysocarpa Ashe – fireberry hawthorn, scarlet hawthorn

[*Crataegus coccinea* L., in part]

C. crus-galli L. – cockspur hawthorn

C. flabellata (Spach) Kirchn. – fanleaf hawthorn

C. flava Aiton – yellow hawthorn

C. harbisonii Beadle – Harbison hawthorn: Cullman Co.

C. marshallii Eggl. – parsley hawthorn

C. phaenopyrum (L.f.) Medik. – red hawthorn, Washington-thorn

?*C. pulcherrima* Ashe – beautiful hawthorn

C. punctata Jacq. – dotted hawthorn

C. spathulata Michx. – littlehip hawthorn

?*C. triflora* Chapm. – threeflower hawthorn

C. uniflora Münchh. – oneflower hawthorn, dwarf hawthorn

C. viridis L. – green hawthorn

Malus angustifolia (Aiton) Michx. – southern crabapple

[*Pyrus angustifolia* Aiton]

**M. pumila* Mill. – common apple

M. coronaria (L.) Mill. – sweet crabapple

[*Malus bracteata* (L.H. Bailey) Rehder]

[*Malus glaucescens* Rehder]

[*Pyrus coronaria* L.]

Neviusia alabamensis A. Gray – Alabama snow-wreath

Physocarpus opulifolius (L.) Maxim. – ninebark

Prunus alabamensis C. Mohr – Alabama black cherry

[*Prunus serotina* var. *alabamensis* (C. Mohr) Little]

P. americana Marshall – American plum

P. angustifolia Marshall – Chickasaw plum

P. caroliniana (Mill.) Aiton – Carolina laurelcherry, cherry-laurel

P. mexicana S. Watson – Mexican plum

P. nigra Aiton – Canada plum

[*Prunus americana* var. *lanata* Sudw.]

[*Prunus americana* var. *nigra* (Aiton) Waugh]

[*Prunus lanata* (Sudw.) Mack. & Bush]

**P. persica* (L.) Batsch. – peach

P. serotina Ehrh. – black cherry, wild cherry

P. umbellata Elliott – flatwoods plum, hog plum, sloe plum

**Pyracantha coccinea* M. Roem. – firethorn

**P. fortuneana* (Maxim.) H.L. Li

[*Pyracantha crenato-serrata* (Hance) Rehder]

**P. koidzumii* (Hayata) Rehder

**Pyrus calleryana* Decne. – Bradford pear

**P. communis* L. – common pear

**Rosa bracteata* J.C. Wendl. – Macartney rose, hedge rose

**R. canina* L. – dog rose: Mobile Co.

R. carolina L. – Carolina rose, wild rose

[*Rosa humilis* Marshall]

R. eglanteria L. – sweetbrier rose

[*Rosa rubiginosa* L.]

**R. laevigata* Michx. – Cherokee rose

?*R. moschata* Herrm. – musk rose

**R. multiflora* Thunb. – baby rose, multiflora rose

R. palustris Marshall – swamp rose

R. setigera Michx. – prairie rose, climbing rose

R. virginiana Mill. – Virginia rose

**R. wichuraiana* Crép. – memorial rose

NOTE: 'Dorothy Perkins' is the cultivar commonly spreading from old homesites and along highways.

Rubus allegheniensis Porter – Allegheny blackberry: Madison Co.

R. argutus Link – common blackberry, sawtooth blackberry

[*Rubus betulifolius* Small]

[*Rubus floridus* Tratt.]

**R. bifrons* Vest ex Tratt. – European blackberry, Himalayan berry: Bibb, Tuscaloosa cos.

R. canadensis L. – smooth blackberry, thornless blackberry: Clay, Lee cos.

R. cuneifolius Pursh – sand blackberry

R. flagellaris Willd. – northern dewberry

R. hispidus L. – bristly dewberry, swamp dewberry

**R. occidentalis* L. – black raspberry

?*R. odoratus* L. – thimbleberry, flowering raspberry

NOTE: Reported from Jackson Co. by Dean (1961).

R. trivialis Michx. – southern dewberry

**Spiraea cantoniensis* Lour. – Reeves spiraea

**S. thunbergii* Siebold ex Blume – bridal wreath

S. tomentosa L. – hardhack

?*S. virginiana* Britton – Virginia spiraea

Rubiaceae

Cephalanthus occidentalis L. – buttonbush

?*Pinckneya bracteata* (Bartram) Raf. – pinckneya, fever-tree
[*Pinckneya pubens* Michx.]

Rutaceae

**Poncirus trifoliata* (L.) Raf. – trifoliolate orange

Ptelea trifoliata L. – common hoptree, wafer-ash

Zanthoxylum americanum Mill. – common prickly-ash

Z. clava-berculis L. – Hercules-club
[*Zanthoxylum macrophyllum* Nutt.]

Salicaceae

**Populus alba* L. – white poplar

P. deltoides Bartram ex Marshall – eastern cottonwood

P. heterophylla L. – swamp cottonwood

**P. nigra* L. – Lombardy poplar

**Salix babylonica* L. – weeping willow

S. caroliniana Michx. – Coastal Plain willow
[*Salix longipes* Shuttlew. ex E.S. Anderson]

**S. cinerea* L. – pussy willow, large gray willow: Colbert Co.

S. eriocephala Michx. – Missouri willow: to the large number of Alabama records

cited by Argus (1985, 1986) for this species should be added Calhoun, Coffee, Covington, Dale, Escambia, Geneva, and Monroe cos.

?*S. floridana* Chapm. – Florida willow

S. humilis Marshall – prairie willow, upland willow

S. nigra Marshall – black willow

?*S. rigida* Muhl. – heartleaf willow

S. sericea Marshall – silky willow

Santalaceae

Nestronia umbellula Raf. – nestronia

Pyrularia pubera Michx. – buffalo nut

Sapindaceae (incl. Aceraceae and Hippocastanaceae)

NOTE: Aceraceae and Hippocastanaceae have traditionally been regarded as distinct from Sapindaceae.

Acer barbatum Michx. – Florida maple

[*Acer floridanum* (Chapm.) Pax]

[*Acer saccharum* var. *floridanum* (Chapm.) Small & A. Heller]

[*Acer saccharum* ssp. *floridanum* (Chapm.) Desmarais]

A. leucoderme Small – chalk maple

[*Acer saccharum* var. *leucoderme* (Small) Rehder]

[*Acer saccharum* ssp. *leucoderme* (Small) Desmarais]

A. negundo L. – boxelder

A. nigrum F. Michx. – black maple

[*Acer saccharum* var. *nigrum* (F. Michx.) Small]

[*Acer saccharum* ssp. *nigrum* (F. Michx.) Desmarais]

?*A. pensylvanicum* L. – striped maple

A. rubrum L. – red maple

var. *rubrum*

var. *drummondii* (Hook. & Arn. ex Nutt.) Sarg.

[*Acer drummondii* Hook. & Arn. ex Nutt.]

A. saccharinum L. – silver maple

A. saccharum Marshall – sugar maple

NOTE: Some authors follow Desmarais (1952) and treat *A. barbatum*, *A. nigrum*, and *A. leucoderme* as subspecific taxa within an *A. saccharum* complex.

Aesculus flava Soland. ex Hope – yellow buckeye

[*Aesculus octandra* Marshall]

A. glabra Willd. – Ohio buckeye

A. parviflora Walter – bottlebrush buckeye

A. pavia L. – red buckeye

A. sylvatica Bartram – painted buckeye

[*Aesculus georgiana* Sarg.]

**Koelreuteria paniculata* Laxm. – golden rain tree

Sapindus saponaria L. – wingleaf soapberry, Florida soapberry

[*Sapindus marginatus* Willd.]

Sapotaceae

NOTE: Pennington (1991) treats *Bumelia* as synonymous with *Sideroxylon*. Except for Kartesz (1994), very few American authors have done likewise for more than a century.

Sideroxylon lanuginosum Michx. – gum buckthorn, gum bully

[*Bumelia lanuginosa* (Michx.) Pers.]

S. lycioides L. – buckthorn, buckthorn bully

[*Bumelia lycioides* (L.) Pers.]

S. reclinatum Michx. – smooth buckthorn: Mobile Co.

[*Bumelia reclinata* (Michx.) Vent.]

S. thornei (Cronquist) T.D. Penn. – swamp buckthorn: Houston Co.

[*Bumelia thornei* Cronquist]

Saxifragaceae (see Grossulariaceae and Hydrangeaceae)

Scrophulariaceae

**Paulownia tomentosa* (Thunb.) Siebold & Zucc. ex Steud. – princess-tree

Simaroubaceae

**Ailanthus altissima* (Mill.) Swingle – ailanthus, tree-of-heaven

Solanaceae

Lycium carolinianum Walter – Christmas-berry, Carolina wolf-berry

Staphyleaceae

Staphylea trifolia L. – American bladdernut

Sterculiaceae

**Firmiana simplex* (L.) W. Wight – Chinese parasol-tree, varnish-tree

[*Firmiana platanifolia* (L.f.) Schott & Endl.]

Styracaceae

NOTE: The nomenclature used for *Halesia* follows Reveal and Seldin (1976).

Halesia carolina L. – little silverbell

[*Halesia parviflora* Michx.]

H. diptera J. Ellis – two-wing silverbell

H. tetraptera J. Ellis – Carolina silverbell

[*Halesia carolina* of authors, not L.]

Styrax americanus Lam. – American snowbell

[*Styrax pulverulentus* Michx.]

NOTE: The gender of the genus *Styrax* has been a source of controversy. It is neuter according to Wood and Channell (1960) and Howard (1974); feminine according to Gonsoulin (1974); and masculine according to Nicholson and Steyskal (1976). We believe Nicholson and Steyskal to be correct.

S. grandifolius Aiton – bigleaf snowbell

Symplocaceae

Symplocos tinctoria (L.) L'Hér. – horse sugar, sweetleaf

Theaceae

Gordonia lasianthus (L.) J. Ellis – loblolly-bay
Stewartia malacodendron L. – Virginia stewartia

[*Stuartia malacodendron* (L.) L'Hér]

S. ovata (Cav.) Weath. – mountain camellia

[*Stuartia pentagyna* L'Hér.]

Thymelaeaceae

Dirca palustris L. – leatherwood

Tiliaceae

NOTE: Some authors consider *Tilia caroliniana*, *T. heterophylla*, and *T. michauxii* to be synonymous with *T. americana* (Hickok & Anway 1972). We follow Hardin (1990) in this treatment.

Tilia americana L.

var. *americana* – American basswood,
American linden

var. *caroliniana* (Mill.) Castigl. – Carolina
basswood
[*Tilia caroliniana* Mill.]

var. *heterophylla* (Vent.) Loudon – white
basswood
[*Tilia heterophylla* Vent.]
[*Tilia michauxii* Nutt. – Michaux
basswood]

Ulmaceae

?*Celtis iguanaea* (Jacq.) Sarg. – iguana hack-
berry

C. laevigata Willd. – sugarberry

C. occidentalis L. – common hackberry

C. tenuifolia Nutt. – dwarf hackberry

[*Celtis georgiana* Small]

[*Celtis mississippiensis* Bosc]

[*Celtis smallii* (Beadle) Sarg.]

[*Celtis tenuifolia* var. *georgiana* (Small)
Fernald & B.G. Schub.]

Planera aquatica J.E. Gmel. – water-elm

Ulmus alata Michx. – winged elm

U. americana L. – American elm, white elm

U. rubra Muhl. – slippery elm

[*Ulmus fulva* Michx.]

U. serotina Sarg. – September elm

?*U. thomasi* Sarg. – rock elm

[*Ulmus racemosa* D. Thomas]

Urticaceae (incl. Moraceae)

NOTE: Moraceae has traditionally been
treated as distinct from Urticaceae.

**Broussonetia papyrifera* (L.) Vent. – paper
mulberry

**Maclura pomifera* (Raf.) C.K. Schneid. –
Osage-orange, bois d'arc

NOTE: Historical evidence suggests that
this midwestern species did not occur east
of the Mississippi River prior to Euro-
pean settlement (Elias 1987), but native
Americans may earlier have extended the
original geographic range through trade
because the tree was so much valued for
bow-wood.

**Morus alba* L. – white mulberry

M. rubra L. – red mulberry

Verbenaceae

Callicarpa americana L. – American beautyberry

**Lantana camara* L. – common lantana

**L. horrida* Humb., Bonpl. & Kunth – spiny
lantana

**Verbena brasiliensis* Vellozo – tall verbena

**Vitex agnus-castus* L. – chaste-tree

CLASS LILIOPSIDA**MONOCOTYLEDONS OR MONOCOTS**

NOTE: These plants were formerly classified
as the Subclass Monocotyledoneae within
the Class Angiospermae.

Agavaceae

NOTE: The genus *Yucca* has traditionally
been included within the Liliaceae.

Yucca aloifolia L. – Spanish dagger, aloe yucca

Y. filamentosa L. – Adam's needle, bear-grass
[*Yucca flaccida* Haw.]

[*Yucca filamentosa* var. *smalliana* (Fernald)
H.E. Ahles]

[*Yucca smalliana* Fernald]

Y. gloriosa L. – Spanish bayonet, moundlily
yucca

?*Y. recurvifolia* Salisb. – curveleaf yucca

Arecaceae (Palmae)

Rhapidophyllum hystrix (Pursh) H. Wendl.
& Drude ex Drude – needle palm

Sabal minor (Jacq.) Pers. – blue palm, dwarf
palmetto

**S. palmetto* Lodd. ex Schult. – cabbage pal-
metto: Houston, Mobile cos.

Serenoa repens (Bartram) Small – saw palmetto
[*Serenoa serrulata* (Michx.) G. Nicholson]

Poaceae (Gramineae)

Arundinaria gigantea (Walter) Muhl.

ssp. *gigantea* – giant cane

ssp. *tecta* (Walter) McClure – switch cane

[*Arundinaria tecta* (Walter) Muhl.]

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SUPPLEMENTAL NOTES ON *RHYNCHOSPORA* *CRINIPES* AND RELATED SPECIES IN SECTION *FUSCAE* (CYPERACEAE)

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ABSTRACT

Rhynchospora crinipes Gale and related species are considered as to sectional disposition, taxonomic relationships, geography and ecology. New distributional information is added.

RESUMEN

Se consideran *Rhynchospora crinipes* Gale y las especies próximas en cuanto a su disposición seccional, relaciones taxonómicas, geografía y ecología. Se añade información nueva de su distribución.

INTRODUCTION

Until recently, *Rhynchospora crinipes* Gale has been one of the least known of native beakrushes, all knowledge of it being confined to Gale's description and illustrations (1944: 173, & pl. 823, figs. 2A, 2B) of two specimens on deposit at the U.S. National Herbarium. Somewhat later G. Kükenenthal (1950: 106) in his revision of the the "fuscae," still with only these two specimens to go on, recognized the taxon but at a reduced rank, treating it as a variety of *R. filifolia*. Both specimens were collected in June 1868 by Dr. Charles Mohr from the vicinity of Mobile, Alabama. Over the ensuing years many botanists, myself included, searched in vain to relocate Mohr's distinctive plant, particularly since no one knowledgeable working in the genus doubted the morphologic distinctness of the taxon, whatever their judgement as to its appropriate nomenclatural rank.

Reasons for difficulty in finding *R. crinipes* are plain enough. Mohr's label information is scanty and at the same time somewhat misleading. The holotype label reads "ditches, borders of ponds, June 1868," that on the paratype "low but dry places, roadsides (exsiccated), June 1868." This information, while adequate to describe habitat for most *Rhynchospora* known from the Mobile area, provides no lead to the very specialized habitat of *R. crinipes*. It remained for Dr. Loran C. Anderson (1988) to do this in his excellent article, which is the first authentic report of the continued existence of *R. crinipes*. In it he notes finding, during botanical expeditions by

canoe in the summers of 1987 and 1988, several viable populations from within the Big Coldwater drainage in Santa Rosa County, northwestern Florida. Big Coldwater Creek is one of the finer examples of a pristine blackwater stream in the Gulf South and he describes it very well. Since such streams are not rare in both the Atlantic and Gulf Coastal Plain, other botanists, armed for the first time on where precisely to look, have succeeded in finding this plant over a five-state area. More information on such discoveries will be given under *R. crinipes* in the treatment below.

This particular work is intended to bring recent fieldwork and studies on *Rhynchospora crinipes* into a taxonomic and ecologic context, in hope that it would serve as an aid to conservation of a rare species and its unique habitat. Thus, below, is a synoptical treatment of *Rhynchospora crinipes* and related North American species in the Section *Fuscae*.

TAXONOMY

The two outstanding students of *Rhynchospora* in recent years remain Dr. Shirley Gale for her 1944 revision of "Eurhynchospora" (now treated as subgenus *Rhynchospora*) and Dr. Georg Kükenenthal for his revisional studies of the entire genus (1949, 1950). Of particular interest, I think, is the fact that neither had much if any field experience with *Rhynchospora*, their remarkable effort coming instead from a careful study of herbarium material. Their taxonomy can scarcely be improved on by those who are accustomed to study these plants in the field. Their work is made even more useful simply because both were so consistent in their concepts of species and so willing to express doubt when doubt was justified.

Of the two, the more conservative in assigning specific rank appears to have been Dr. Kükenenthal, perhaps because of his having to do the genus worldwide. This difference also shows up as to how complexes of species should be ranked. Gale (l.c.) broke what was then treated as Section *Eurhynchospora* of Subgenus *Distylis* into 12 "series" basing these largely on what previous workers such as C.B. Clarke, J.K. Small, etc. had designated as sections, in some cases simply reducing them in rank, in others breaking a section into series, as was true in regard to Sect. *Fuscae* C.B. Clarke. Here, her decision seems to have merit since her Series *Fuscae* and *Fasciculares* do constitute two natural and distinct sections within the section *Fuscae* as conceived by Clarke, later by Kükenenthal. A key to the proposed sections is below:

1. Tubercle edges with at least some setae; fruits narrowed to a stipe-like vari-
ously setose or setulose receptacle, the lenticular body under 1 mm wide
and mostly broadest above the middle, the surfaces lustrous, often with a
pale, glassy central disc Sect. **Fuscae**
1. Tubercle edges smooth; fruits not narrowed to a stipe-like base, the lenticu-
lar body over 1 mm wide (except for *R. fernaldii*) and broadest at the middle,
the surfaces smoothish but dull Sect. **Fasciculares**

Since this particular report bears only on *R. crinipes* and its relatives in the proposed Section *Fuscae* I am deferring a consideration of the *Fasciculares* until a later date. The species accounts below are based upon the examination of many hundreds of specimens (and in field work) but for economy only recent collections records will be cited, along with maps to show general distribution.

Rhynchospora Vahl, Enum. Pl. 2:229. 1806, subgenus **Rhynchospora** Sect. **Fuscae** (C.B. Clarke) Kral, stat. nov. *Rhynchospora* Series B. *Diplostyleae* Sect. 4, *Fuscae* C.B. Clarke in Urban, Symb. Ant. 2:105. 1900 (in part); *Rhynchospora* V. *Glomeratae* Small, Man. SE Fl. 175. 1933 (in part); *Rhynchospora* Sect. *Eurhynchospora* Ser. 4. *Fuscae* (C.B. Clarke) Gale, Rhodora 46:169. 144.

Solitary to cespitose, sometimes scaly-rhizomatous, perennials. Culms mostly erect to ascending-arching, subtrigonous, leafy, the leaves filiform to linear, blades flat to conduplicate or canaliculate, apically narrowed to triquetrous tips. Inflorescence of (1-)2-4(-7) mostly turbinate to hemispheric compounds of fascicles. Spikelets lanceoloid to narrowly ellipsoid, producing 2-4 or more fruits, the scales loosely spirally imbricate; receptacle often stipe-like, frequently setose; perianth of 6 antrorsely barbellate bristles, these always overtopping fruit body, often setose at or toward base; stamens 2 to 3; fruit body mostly obovoid to ellipsoid, biconvex, under 1 mm wide, broadest above middle, the faces smooth, usually glossy; tubercle triangular to triangular-subulate, flattened, its edges variably setulose-ciliate.

TYPE SPECIES:—*Rhynchospora fusca* (L.) W.T. Aiton.

Six well-marked species, with *R. fusca* in eastern Canada and New England south in the Coastal Plain to Maryland, the other five primarily southward, mostly in the Atlantic and Gulf Coastal Plains with some extending yet southward into the Antilles and/or Mexico and Mesoamerica.

Below is a key to species, this followed by some notes on the individual species as I see them.

KEY TO SPECIES OF SECT. *FUSCAE*

- 1. Spikelets (4.5-)5-7 mm long.
- 2. Fruit body broadly ellipsoid to obovoid; leaf blades filiform to linear.
- 3. Plants sparsely or densely cespitose, but also strongly clonal by slender rhizomes; stipe joint stout or lacking; leaf blades filiform.
- 4. Culms few per clump; longer involucre bracts of terminal fascicle much exceeding it; fruit from stipe base to tubercle tip ca. 2.5 mm, the stipe smooth; fruit body tumidly biconvex; tubercle edge usually setulose only at base; northern 1. *R. fusca*
- 4. Culms densely disposed; longer involucre bracts of terminal fascicle barely if at all exceeding it; fruit from stipe base to tubercle tip ca. 2 mm, the short stipe and tubercle edges setose and setulose respectively; fruit body more shallowly biconvex; southern 2. *R. pleiantha*

- 3. Plants caespitose or, in no. 4 stoloniferous, rooting from elongated buried lower nodes when toppled by flood, then strongly clonal; stipe joint short to elongate, it and receptacle, smooth to variously setose or setulose; leaf blades filiform to linear.
- 5. Principal leaf blades no wider than 2 mm; fruit from stipe base to tubercle tip to 2.7 mm; fruit stipe joint smooth to sparsely setose, to 0.4 mm; fruit body obovoid, ca. 1 mm wide; spikelet clusters few, mostly 1–3; tubercle triangular-subulate; plants strictly caespitose even when toppled 3. *R. harperi*
- 5. Principal leaf blades 2–5 mm wide; fruit from stipe base to tubercle tip 2.8–3.3 mm; fruit stipe joint slightly to densely setose, 0.5–1 mm; fruit body narrowly obovoid, ca. 0.8 mm wide; spikelet clusters several, usually 4 or more; tubercle triangular, or sides slightly concave; plants caespitose but clonal when toppled by flood, then rooting at buried lower nodes and stoloniferous 4. *R. crinipes*
- 2. Fruit body narrowly oblong-ellipsoid; leaves filiform 5. *R. curtissii*
- 1. Spikelets 3–4 mm long 6. *R. filifolia*

1. *Rhynchospora fusca* (L.) W.T. Aiton, Hort. Kew. ed. 2, 1:127. 1810.
Schoenus fuscus L., Sp. Pl. ed. 2, 2:1664. 1763.

Phaeocephalum fuscum House, Amer. Midl. Naturalist. 6:202. 1920.

Rarely solitary, mostly sparsely caespitose perennial to 4(–5) dm high, clonal by slender (1–2 mm) imbricate-scaly rhizomes. Culms wiry, ascending to excurved, subterete, multicostate, at midculm 0.5–1 mm thick, leafiest at and toward base. Leaves erect or bowed outward, the principal ones mostly 0.5–2 dm long, the sheath with broad, scarious red-mottled border, at apex with a convex “V” shaped low scarious ligule; blades narrowly linear to filiform, at base to 1.5(–2) mm wide, narrowly involute, upblade gradually narrowing to broadly, then narrowly canaliculate, tapering to a sulcate triangular apex, the tip typically blunt, the margins smooth. Fascicles of spikelets mostly compound, appearing to be 1–3(–4), all exceeded by one or more subtending, setaceous-tipped bracts, cylindric or (mostly) narrowly to broadly turbinate, rarely hemispheric, 1–1.5 x 0.5–1.5 cm, sparse to dense, the terminal complex of up to 3 or even more approximate fascicles, the laterals progressively more distant longer-peduncled, longer-bracted, downculm; spikelets broadly to narrowly ellipsoid-lanceoloid, 5–7 mm, narrowly acute, pale to deep red-brown, scales several, the lowest barren, often cuspidate-aristate; fertile scales, mostly 2–3(–4), narrowly ovate to oblong-lanceolate, 4–5(–6) mm, acute, convex to navicular, the strong midcosta excurrent as mucro or cusp; stipe and receptacle stubby, 0.2–0.3 mm, usually smooth; perianth mostly of 6, antrorsely barbellate bristles to 2.5 mm, the longer extending past base of tubercle, mostly past its tip; stamens 2–3, anthers 2–2.5 mm long; fruit body tumidly lenticular, obovoid, 1–1.3 mm, narrowly and inconspicuously margined, at apex with a shallow trough below the sharply raised tubercle base, faces

pale to deep brown, lustrous, longitudinally finely lined, transversely very finely rugulose with wavy rows of very narrow, vertical cancellae, sometimes also with lines of shallow pits; tubercle strongly subulate, (0.7–)1–1.2(–1.5) mm, the edges scabrid-setulose only toward base. Figure 1.

Wet to moist sandy (often sphagnum) peats of bogs, pondshores, seeps, acidic wetlands, northeastern North America, in Canada from the maritimes westward to Lake Superior region, in the U.S. from New England westward from New York to northern Illinois, Wisconsin and Minnesota, southward in the Coastal Plain to New Jersey and Maryland. Europe.

Relationships of this widespread sedge are plainly closest to *R. pleiantha* and will be taken up there. No specimen citations are given here.

2. *Rhynchospora pleiantha* (Kük.) Gale, Rhodora 46:171. 1944. *R. filifolia* var. *pleiantha* Kük. Feddes Repert. Spec. Nov. Regni Veg. 23:208. 1926. TYPE: CUBA. PINAR DEL RIO: Laguna Sta. Maria, 22 Aug 1923, *Ekman 17242a* (LECTOTYPE: NY; ISOTYPE: US).

Densely cespitose perennial (1.7–)2–4.5(–5.3) dm high, strongly clonal by slender (to 2 mm thick) scaly rhizomes. Culms wiry, ascending to excurved, obtusely angled or subterete, multicostate, at midculm mostly 0.4–0.7 mm thick, leafiest at and toward base. Leaves erect to bowed outward, principal ones 1–2 dm long, the blades filiform, proximally shallowly to deeply canaliculate, upblade becoming convolute or conduplicate, then triquetrous to a short, blunt, scabrid-edged tip. Fascicles of spikelets 1–2(–3), mostly narrowly to broadly turbinate, rarely hemispheric, each with few to many pale to deep red-brown, lanceoloid spikelets, the terminal fascicle largest, sometimes lobed, equalled or slightly exceeded by a stiff, erect, linear-setaceous bract. Spikelets 5–7 mm long, acute, scales several, the 2–5 fertile ones narrowly ovate to broadly oblong-lanceolate, (3.5–)4–5 mm, acute, convex to navicular, only the midcosta evident, this excurrent as an aristula; stipe and its receptacle short, rarely to 0.3 mm, from setulose to nearly smooth; perianth of 6 antrorsely barbellate bristles ca. 2–3 mm, extending to tubercle tip or beyond; stamens 2(–3), anthers linear, ca. 2 mm; fruit body biconvex, narrowly to broadly obovoid, 0.8–1 mm, margined and apically broadly but shallowly sulcate below raised edge of style base, usually lustrous brown, often with a paler oval “disc” at center, the surface very finely longitudinally lined, sometimes finely reticulate-cancellate; mature tubercle triangular-subulate, 0.7–0.9 mm setulose only toward slightly decurrent base. Figure 2.

Wet fine sands or sandy peats, mostly around karst ponds or in their environs, Atlantic and Gulf Coastal Plain, North Carolina south to peninsular Florida, western Florida and contiguous southern Alabama. Cuba. Figure 3.

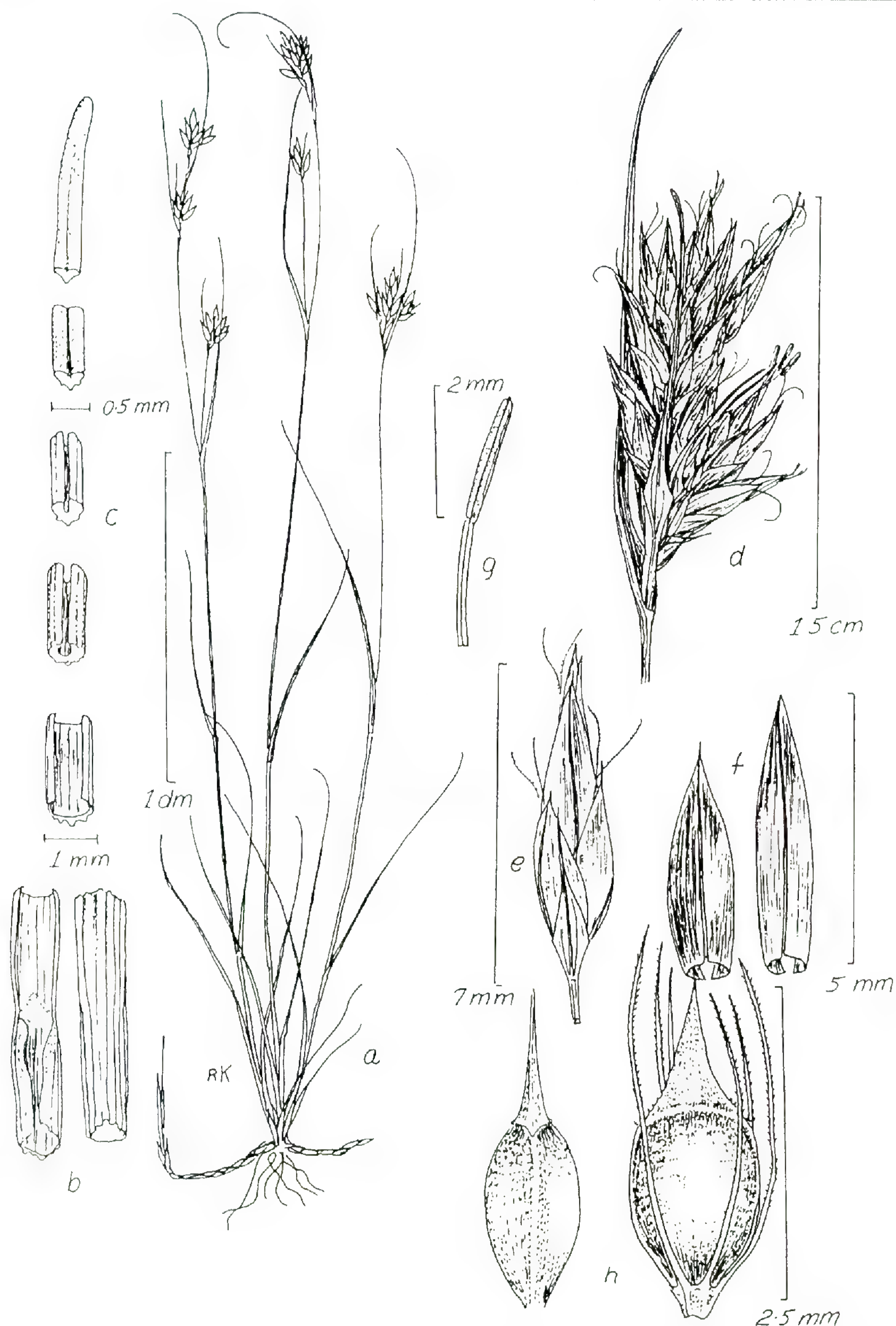


FIG. 1. *Rhynchospora fusca* (Kral 78328). A. Habit sketch. B. Leaf sheath-blade junction, adaxial view (left), abaxial view (right). C. Sectors of leaf blade from distal (bottom) to apical (top). D. Apical compound fascicle. E. Spikelet. F. Fertile scales, lower (left), upper (right). G. Anther and upper filament. H. Mature fruit & perianth, edge view (perianth removed) at left, face view (right).

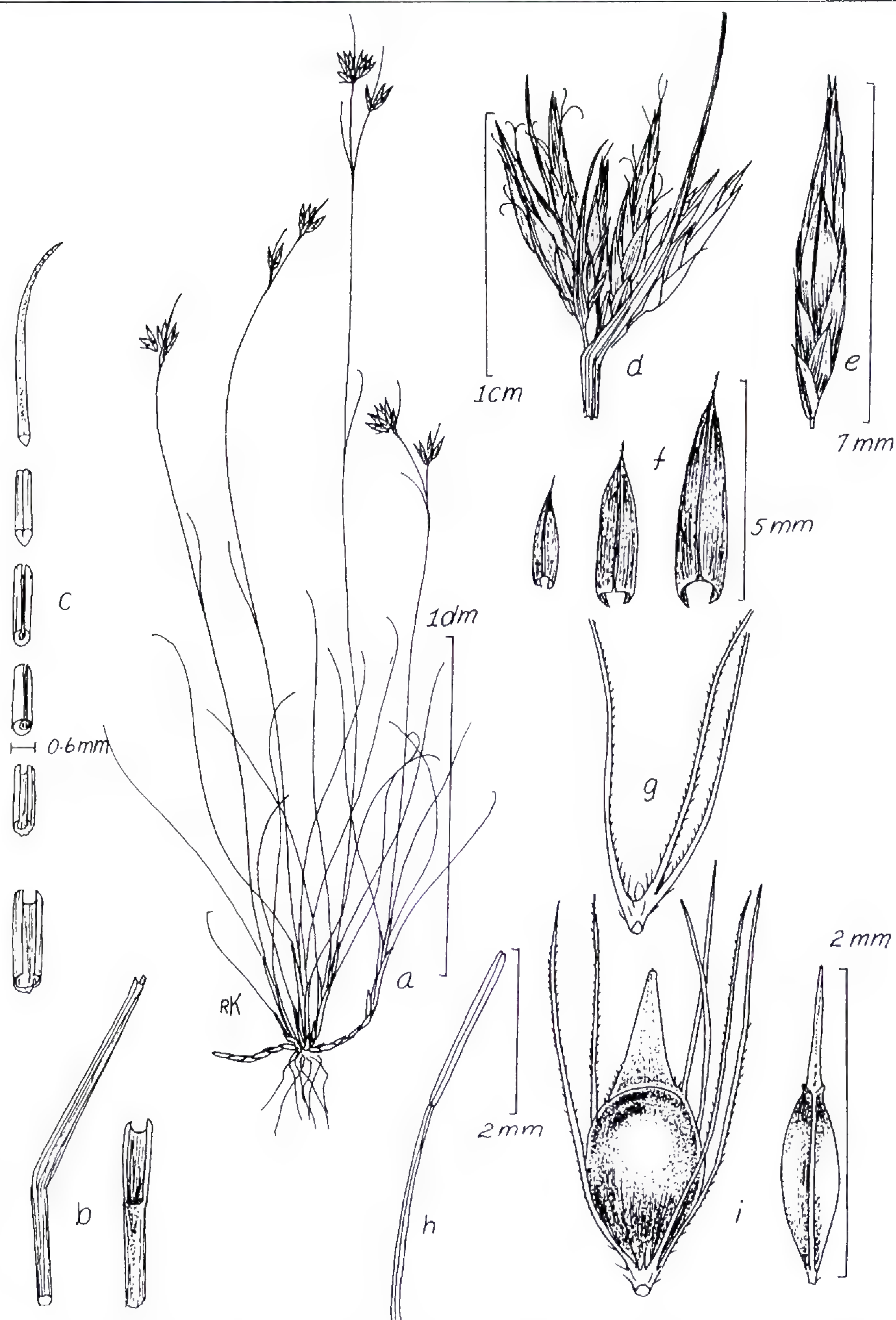


FIG. 2. *Rhynchospora pleiantha* (Kral 81119). A. Habit sketch. B. Leaf sheath-blade junction, abaxial view (left), adaxial view (right). C. Series of sections of leaf blade from near base (bottom) to tip (top). D. Apical fascicle. E. Spikelet. F. Spikelet scales, lowest sterile (left), lower fertile (middle), upper fertile (right). G. Receptacle and stipe with 3 bristles. H. Top of one stamen. I. Mature fruit with stipe and perianth (left), side view of fruit body (right).

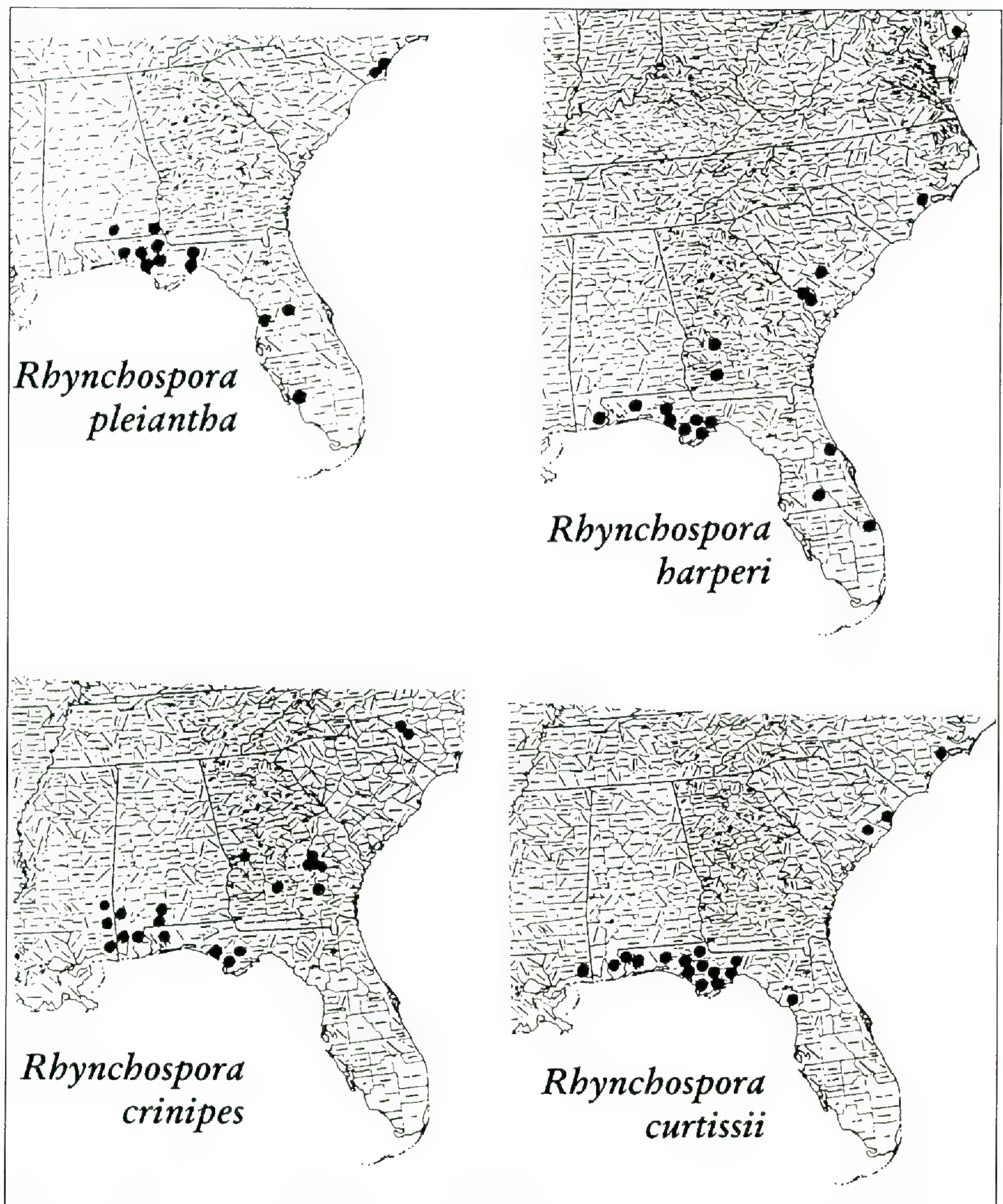


FIG. 3. Distribution of *Rhynchospora pleiantha*, *harperi*, *crinipes*, and *curtissii* in the southeastern United States.

Gale (l.c., p. 172), as mentioned earlier here, appears to have it right in determining that *R. pleiantha* is a close relative of the more northern *R. fusca*. As she mentioned in the synonymy, Dr. R. Harper, a very astute observer and collector of sedges, considered the two conspecific. Both are low, cespitose and with wiry culms and leaves of similar dimensions; both have few fascicles per culm, these generally rather closely spaced at and near culm apex, these similarly narrowly to broadly turbinate and of similar color; the fruits, including receptacle-stipe, are similar in shape, color

and most surface features. Interestingly, Gales description of *R. pleiantha* excludes the slender scaly rhizomes abundantly produced by this species and which are likewise produced by *R. fusca*, a feature which ties the two even more closely together. Other differences mentioned by Gale are however consistent and enough to “make” species, as in the short stipe-receptacle and the perianth bases of *R. fusca* being smooth or nearly so, the more tumid fruits consistently, if slightly, longer and broader. Also, the setaceous bract subtending the terminal fascicle much exceeds it in *R. fusca*, whilst in *R. pleiantha* is ranges from slightly shorter to slightly longer than that fascicle. But a consistent taxonomy would, if the two were sympatric at all, be to make them geographic variants.

In habitat *R. pleiantha* is remarkably uniform over its range. It can form bands along the shores of karst ponds and lakes, these fluctuating borders providing a substrate of fine sand and peat.

While many more specimens from herbaria were studied from loans, I am citing only those here at VDB, several of these representing numerous duplicates of my numbers, now distributed or soon to be (here and subsequently indicated by “t.b.d.”):

Specimens examined: U.S.A. ALABAMA. Covington Co.: sandy upper shores of Blue Pond, Blue Springs Wildlife Mgmt. Area, SW Andalusia, 1 Jun 1970, *Kral* 39499 (VDB & widely distributed). Houston Co.: sandy peaty shores of limesink pond by co. 4, ca. 4 mi W Chattahoochee State Park entrance, *Kral* 47261 (VDB & widely distributed); sandy peat at edge of Indigo Pond, SE of Cottonwood, 20 Aug. 1977, *R. Kral* 60845 (VDB & widely distributed); sandy peaty edge of doline by co. 8, W of entrance to Chattahoochee State Park, 20 Aug. 1993, *R. Kral* 83230 (VDB, set to be distributed). FLORIDA. Bay Co.: just to S side of FLA 20, 4.4 mi E its jct. with FLA 77, generally N of Vicksburg, 14 Aug 1990, *R. K. Godfrey* with *A. Gholson* 83950 (FSU, GH, VDB); sandy peat of shores of small doline S side FL 20, N of Bennett, ca 3 mi W of Iconfina River, 18 Jul 1992, *R. Kral* 81199 (BM, BRCH, CM, CTB, FSU, GH, K, KANU, M, MICH, MO, MSC, NCU, NY, PH, SMU, VDB). Calhoun Co.: sandy peaty exposed shores and bottom of cypress-myrtle-leaved holly pond, U. S. Rt. 90, 3 mi E of Bay Co. line, W of Clarksville, 10 Aug. 1976, *R.K. Godfrey* 75328 (FSU, VDB, etc.). Hernando Co.: 3 mi N of Weeki Wachee Springs; abundant on moist to wet sands at margin of hypericum pond, 9 Jun 1958, *R. & M. Kral* 6786 (FLAS, FSU, GH, USE, VDB, etc.). Jackson Co.: sandy peaty shores of Race Pond, sect. 1, T4N, R8W, W of Apalachee Wildlife Mgmt. Area on Lake Seminole, *R. Kral* with *A. Gholson* 60789 (VDB). Leon Co.: sandy soil, upper exposed margins of pond, sinkhole pond amidst sand ridges near Springhill Rd., ca. 1/4 mi S of Capital Circle, S of Tallahassee, 12 Jun 1976, *R.K. Godfrey* 75062 (FSU, VDB); ca. 4 mi S of Tallahassee on sandy peat of upper margin of limestone pond in longleaf pine-turkey oak forest; plants stoloniferous, 15 Aug 1962, *R. Kral* & *R.K. Godfrey* 15581 (FSU, VDB); sandy peaty shores of Dog Lake, SW of Tallahassee in Apalachicola National Forest, 3 Jul 1993, *R. Kral* 82783 (BRCH, MO, VDB). Wakulla Co.: damp sandy shores of a lake between Tallahassee and St. Marks, anno ca 1843, *F. Rugel* 601 (BM, FLAS, VDB). Walton Co.: ca 2 mi E of county line by US 98; sandy border of small pond within sight of Gulf, 12 Jul 1963, *R. Kral* 17750 (VDB); sandy peat at edge of Lake Chipley SW of S arm Juniper Lake and ca 1 mi E of US 331, NW side De Funiak Springs, 23 Jul 1993, *R. Kral* 82930 with *G. Moore* (BRCH, CM,

CTB, GA, GH, IBE, MICH, MO, NCU, NY, OSC, PH, VDB). **Washington Co.:** sandy shores of Chain Lakes, W of Greenwood, 6 Jul 1963, *R.K. Godfrey & N.C. Henderson* 62955 (FSU, VDB); sandy peat of shores of pond, campsite, Pine Log State Forest ca 0.5 mi W of FL 79, 15 Aug 1992, *R. Kral* 81506A (BRCH, CTB < GH, MO, VDB); sandy peat of shore of 5-acre doline ca 1/2 mi N of FL 20, ca 4.6 mi E of jct. FL 77, 16 Aug 1992, *R. Kral* 81541 (FSU, MO, VDB). **NORTH CAROLINA. Brunswick Co.:** sandy peat at edge of Blue Pond, ca 4.2 mi SW Jackies Creek and NC 133, ca 500 yds NW from McKenzie Pond, 1 Jun 1980, *R. Kral* 65265 (VDB).

3. *Rhynchospora harperi* Small, Fl. SE U.S. 182. 1903. <b9,10>*R. fascicularis* (Michx.) Vahl var. *harperi* (Small) Kük., Bot. Jahrb. Syst. 75:111. 1950. TYPE: U.S.A. GEORGIA. PULASKI CO.: wet pine barrens ca 3 mi E of Hawkinsville, *R.M. Harper* 1337 (HOLOTYPE: NY; ISOTYPE: US).

R. leptorhyncha sensu Small, Fl. SE U.S. 195. 1903, non C. Wright, 1871.

Cespitose perennial (3–)5–8(–9) dm high. Culms erect to arching, obtusely angled to subterete, rarely filiform, more often distinctly broader than leaf blades, at ca midculm (0.5–)1–2 mm thick, strongly costate, leafiest at and toward base. Leaves erect to ascending, mostly straight, principal ones 1–2 dm long, blades linear-filiform, 0.5–1.0 mm wide, proximally slightly inrolled (broadly canaliculate), upblade increasingly narrowly conduplicate with midcosta strongly raised abaxially, thence gradually narrowing, adaxially sulcate, to a triangular or subtriquetrous apex, the very tip slightly flattened, blunt, scabrid-margined. Fascicles (1–)2–3, turbinate to hemispheric, 0.7–1.5 × 1–2 cm, each with few-to-many lanceoloid pale to deep red-brown spikelets, the terminal fascicle largest, densest, often lobed or with another immediately subtending, usually atop a distinctly bent or excurved internode, equalled or exceeded by one or more subtending linear-setaceous bracts; spikelets 5–7 mm, narrowly acute; scales several, the 2–4 fertile ones narrowly ovate to broadly oblong-lanceolate, (2.5–)4–5 mm, acute, convex to navicular, only the midcosta evident, this distally scabrid, excurrent as a cusp or aristula; stipe and its receptacle short, 0.2–0.3 mm, usually sparsely setose and setulose; perianth of 6 antrorsely barbellate bristles 1.5–2.5 mm, extending from mid-tubercle to beyond tubercle tip; stamens 2(–3), anthers linear, ca. 2 mm; fruit body biconvex, broadly obovoid, 1–1.4 mm, margined and apically broadly grooved below the narrow, sharply raised tubercle collar, faces glossy, pale to dark brown, often with a paler oval disc at center, finely longitudinally lined, variably low papillate-cancellate, also often transversely with wavy lines of dark punctae; mature tubercle triangular-subulate, (0.8–)0.9–1(–1.1) mm, edges densely pale setulose-scabrid. Figure 4.

Moist to wet sands and peats of pond shallows and shores, Atlantic and Gulf Coastal Plain, from Maryland and Delaware, then North Carolina south to southern Florida, westward to panhandle Florida and southern Alabama. Figure 3.

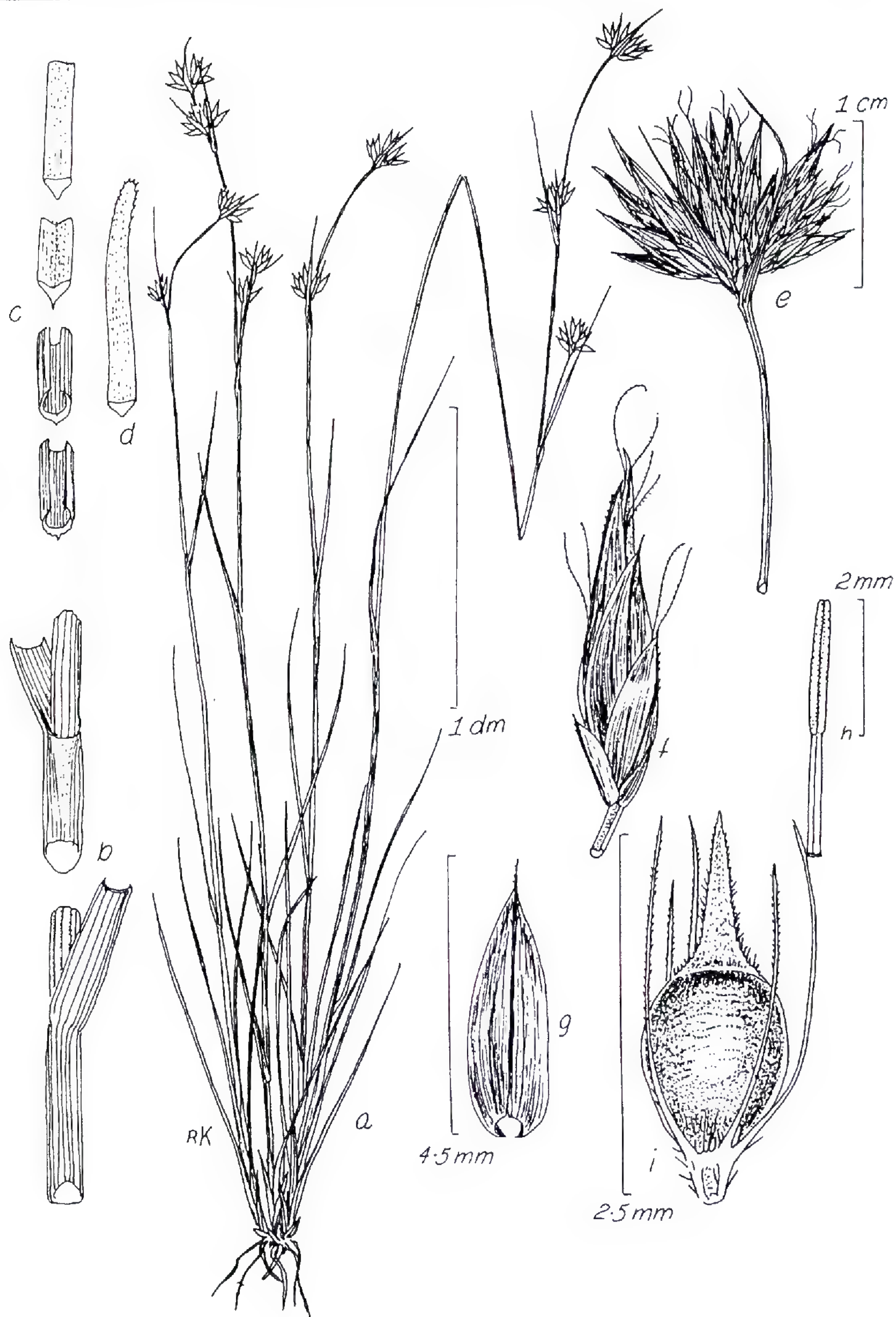


FIG. 4. *Rhynchospora harperi* (Kral 85337). A. Habit sketch. B. Leaf sheath-blade junction, abaxial side (below), adaxial side (above). C. Series of sectors of leaf blade from distal (below) to distal (top). D. Leaf apex. E. Terminal fascicle. F. Spikelet. G. Fertile bract. H. Face view of mature fruit.

Richard LeBlond has reported records for this species, until then thought confined to Florida, Georgia and Alabama so that we now know it from several additional states. My own experience with it thus far is within its area of greatest abundance, namely panhandle Florida, where optimum habitat is pond shallows in *Taxodium ascendens*-*Nyssa* (*biflora*, *ursina*)-*Ilex myrtifolia*-*Cyrilla* in the pine-saw palmetto flats, where it is mostly admixed with various species of shrubby myriandrous *Hypericum*, or along ditches or shallow moats bordering pine savanna bogs. It should be noted that the Delaware and Maryland *R. harperi* is a far cry from that of North Carolina southward, being lower, narrower-leaved, with smaller fascicles, the terminal internode mostly lacking the "bend," the fruits on the short side of the range. However, this material, while strongly resembling *R. filifolia*, would be difficult to place there or elsewhere except in *R. harperi*.

Specimens examined: As is the case with *R. pleiantha* (above), I am citing only those specimens here at VDB: U.S.A. **DELAWARE**. Sussex Co.: Assawoman Pond, 17 Sep 1991, *R.J. LeBlond* 2552 (VDB). **FLORIDA**. Bay/Washington Co.: sandy peat of sloughs in pine-cypress savanna, FL 20 by cry marker, E of Ebro, 9 May 1995, *Kral* 84643 (FSU, GH, MO, VDB). Franklin Co.: deep-banked drainage ditch lined with *Hypericum fasciculatum* 2 mi. E of rte 65 S side Buck Siding Rd, SE1/4 of NW1/4 Sec.9, T7S,R7W, 14 Jul 1988, *L.C. Anderson* 11611 (FSU, VDB); standing water of cypress stringer, S side forest rd 148, between open savannas, 0.4 mi W of rte 65, 6.5 mi S of Sumatra, 23 May 1989, *L.C. Anderson* 12004 (FSU, VDB); wet peaty sand, pond cypress in Tate's Hell Swamp, 1.5 mi E of High Bluff Creek, ca 7.5 mi NE Eastpoint, 28 May 1991, *L.C. Anderson* 13429 (FSU, VDB); abundant over large area of dwarf pond-cypress forest, Tate's Hell Swamp, E of FL 65, *R. K. Godfrey* 83880 with *W. Baker* (FSU, GH, VDB); sandy peats of cutover cypress-gum-pine flats by FL 65, 2.2 mi N of jct. US 98, 3 Jul 1993, *R. Kral* 82800 (BM, BRCH, CLEMS, CM, CTB, FSU, GA, GH, K, KANU, MBM, MICH, MO, MSC, NCU, NY, TENN, TEX, US, USCH, VDB, VSC, WAT, WILLI, WIS); sandy peat of edge of small cypress dome in scrub, end of shell road, East Point, ENE end of FL 65, 20 Jul 1993, *R. Kral* 82846 with *G. Moore* (FSU, GH, K, KANU, MICH, MO, NCU, NY, TEX, USCH, VDB, WIS). Gulf Co.: bog bordered by *Hypericum chapmanii* in clearing of thick *Cyrilla* scrub betw. Daniels Rd. and Wetappo Creek, 4.3 mi S of rte 22, ca 5.5 mi SW Wewahitchka, 20 Jul 1989, *L.C. Anderson* 12170 (FSU, VDB); sandy peaty swale in *Hypericum*-*Cyrilla*-*Nyssa*-pine, flats by Fl 71, 6-7 mi S of Wewahitchka, *R. Kral* 82854 (GH, MICH, MO, NY, USCH, VDB); sandy peat of ditch through slash pine flats, S side US 98, 5 mi W of Franklin Co. line, 21 Jul 1993, *R. Kral* 82868 (BRCH, CM, GA, GH, K, MICH, MO, NCU, NY, TENN, TEX, US, VDB); and same locale but with dwarf cypress, *R. Kral* 82869 (VDB). Liberty Co.: common in shallow water of depression along railroad bordering slashpine flats E of rte 65 a few mi NE Wilma, 10 Jul 1992, *L.C. Anderson* 13706 (FSU, VDB); by Fl. 65 plus or minus 5 mi N of Sumatra, borrow pit, aspect dominant *Hypericum chapmanii* P. Adams, 26 Jul 1993, *R.K. Godfrey* 84647 (FSU, GH, VDB + 43 duplicates elsewhere); sandy peat of shallow *Hypericum* pond by W side FL 65, 22 mi S of Telogia, abundant, 3 Jul 1993, *R. Kral* 82809 (CLEMS, GH, KANU, MO, NCU, NY, TEX, USCH, VDB, VSC, WIS). Martin Co.: slash pine flats at S side Stuart off US 1, pond shallows, 18 Sep 1973, *R. Kral* 51780 (VDB & distributed); sandy peat of shallow *Hypericum*-*Taxodium* pond by Willoughby Ave., ca. 1/4 mi N of jct. co. 722, scarce, 8 Jul 1994, *R. Kral* 83706 (BRCH, FSU, MO, NCU, VDB, NY). Okaloosa Co.: small gum

pond in longleaf pine savanna near gravel rd intersect 1 mi N of Beaver Creek, ca. 3.5 mi N of Fl 4 ca 7 mi E of Munson; Danley Ponds, Blackwater State Forest, 10 Jul 1990, *S.L. Orzell & E. L. Bridges* 14275 (TEX, VDB). **Volusia Co.:** upper transitional zone from open graminoid flatwoods pond to clearcut slash pine flatwoods, ca 4.7 mi W jct. Fl 40 and US 17 in Barberville, 12 Jun 1990, *S.L. Orzell & E.L. Bridges* 13921 (TEX, VDB). **Walton Co.:** sandy peat of pond cypress-pine savanna, FL 20, 1.1 mi E of Bruce, frequent, 18 Jul 1995, *R. Kral* 85337 (BM, BRCH, CM, FSU, GA, GH, K, KANU, MBM, MICH, MO, MSC, NCU, NY, US, VDB). **Washington Co.:** sandy peaty *Nyssa-Taxodium ascendens-Hypericum* flats ca. 1/2-1 mi W of Bay Co. line marker by FL 20 just E of Ebro, 19 Jul 1993, *R. Kral* 82820 (CLEMS, CTB, GH, MICH, MO, MSC, NCU, NY, TEX, US, USCH, VDB, VSC, WAT); Fla 20, 1/8-1/4 mi W of Bay Co. line in cypress-pine savanna, sandy peat, *R. Kral* 85322 (NY, US, VDB); & t.b.d.). **NORTH CAROLINA.** **Onslow Co.:** Camp Lejeune Marine Corps Base, wet peat of graminoid-forb dominated meadow, 2 Aug 1990, *R.J. LeBlond* 1549 (VDB); Camp Lejeune Marine Corps Base, in a 3-acre shallow pond S of the jct. of Sneads Ferry and Marines Rds., 6 Aug. 1990, *R.J. LeBlond* 1552. (VDB).

4. *Rhynchospora crinipes* Gale, Rhodora 46:173. 1944. *R. filifolia* A. Gray var. *crinipes* (Gale) Kük., Bot. Jahrb. 75(1):106. 1950. TYPE: U.S.A. ALABAMA. MOBILE CO.: ditches, borders of ponds, Mobile, 18 Jun 1868, *Charles Mohr s.n.* (HOLOTYPE: US!); dry places, roadsides (exsiccated), Mobile, Jun 1868, *Charles Mohr s.n.* (PARATYPE: US!).

Solitary or cespitose perennial 6–10(–15) cm long, often strongly clonal through toppling by flood, lower internodes thus elongating, rooting at nodes stoloniferously. Culms lax, erect to ascending, excurved distally, at midculm mostly 2–3 mm thick, obscurely trigonous to terete, multicostate, leafy. Leaves lax, the lower ones often trailing after flood, principal ones toward and at culm base, 20–50 cm long; blades narrowly linear, 2–4(–5) mm wide, proximally flattened, at base slightly concave, midcosta slightly raised abaxially, thence upblade more level with midcosta strongly raised abaxially, thence to “v” shaped, with midcosta a sulcus adaxially, very raised abaxially, thence tapering and triquetrous to a subulate tip. Fascicles of spikelets mostly compound, (3–)4–7(–10), mostly narrowly to broadly turbinate, less often hemispheric, ellipsoid or ovoid, 1.2–2 × 1–2.5 cm, all short-pedunculate, the lower ones distant, and much exceeded by subtending foliaceous bract, upculm progressively more approximate and shorter-bracted, the apical ones exceeding or but slightly overtopped by linear-subulate bract(s); spikelets lanceoloid, 5–5.5 mm, acute to acuminate, light red-brown (on flooding darkening to very dark brown, appearing nearly black); fertile scales narrowly ovate to lanceolate, 4–4.5 mm, convex with the evident midnerve excurrent as aristula or mucro; stipe and receptacle 0.5–0.8(–1.0) mm sparsely to densely setose; perianth of 6 ascending, setose-based, antrorsely scabrid bristles 2–2.5 mm reaching above tubercle base, more often to or beyond its tip; stamens typically 2, anthers linear, ca 2 mm; fruits 2–4 per spikelet, the body lenticular, pale-margined, nar-

rowly to broadly obovoid, 1.2–1.5 mm, faces apically concave below sharply raised tubercle base, brown to even castaneous, lustrous, often with a pale glassy midzone, the surface minutely striolate, sometimes transversely minutely rugulose and with wavy rows of dark puncticulae; tubercle triangular, sometimes slightly subulate (concave-edged), 0.7–1.1 mm, setulose-ciliate from base to tip, the slightly lunate base flowing to the strong fruit margin. Figure 5.

Banks, bars, shoals of blackwater streams, less often ditchbanks and sluggish drainage from flatwoods bogs and ponds, Atlantic and Gulf Coastal Plain, North Carolina; Georgia south to northwestern Florida, southern Alabama, southeastern Mississippi. Figure 3.

Rhynchospora crinipes is unquestionably the most distinct species of its subcomplex in Sect. *Fuscae*. In habit it is tallest, has the thickest culms, the broadest leaf blades. While the plants are typically cespitose, in common with the other species, they are unique in their reaction to toppling, in that culm bases when buried by wash produce elongated lower internodes and increase stoloniferously, thus rooting at one or several lower nodes. The plant bases therefore are often more deep-set, stubbornly hanging on through flood cycles, forming extensive clones in the “best” habitat when other species of *Rhynchospora* may wash away. In fact, dislodged plants may for the same reason reroot more readily in similar habitat downstream. So, while rootstocks of the species have been described as rhizomatous, they are truly stoloniferous, very unlike the true rhizomes produced in *R. fusca*, *R. pleiantha* of the subcomplex which are narrower with spirally imbricate scales. It differs from the others in numbers of fascicle compounds, rarely as few as 3 per culm, (generally the maximum number for the others) more often 5 or more per culm. There is overlap in fascicle and bract shape and dimension, as well as in shape and size of spikelet and number of fruit per spikelet, but none in length and indument of stipe and receptacle, this being the longest and shaggiest of the complex. Actually, in the field, a common companion *Rhynchospora* from another complex, namely *R. glomerata* (L.) Vahl bears the strongest resemblance in general dimensions of culm, leaf, and inflorescence (but not clonal by stolon), differing mainly in character of flower and fruit. Within the complex only *R. filifolia* may be abundant in such habitat but is easily distinguished on a basis of habit, being lower, with narrower leaves and culms, but non-clonal by stolon, with fewer and smaller spikelet clusters, smaller spikelets.

Differences between *R. crinipes* and *R. filifolia* are even stronger when one consults the flower and fruit, the former with a longer, hairier stipe-receptacle, a similar shaped fruit body, but longer and not as smooth, a tubercle that is longer, often less triangular (straight-sided).

Thanks to support from Botanists Cary Norquist (U.S. Dept. of Interior,



FIG. 5. *Rhynchospora crinipes* (Kral 85409). A. Habit sketch. B. Leaf apex. C. Sector of leaf midblade, adaxial view. D. Sector of leaf midblade, abaxial view. E. Leaf sheath-blade junction, adaxial view. F. Terminal fascicle. G. Spikelet. H. Face view of mature fruit. J. Fruit with sprouting seed.

Fish & Game, Jackson Office) and Jeryl L. Hilton (Alabama Natural Heritage Program, the Nature Conservancy office, Montgomery) I have been able to do a proper field survey of this *Rhynchospora* over what is presently known to be its geographic range. My notes below on habitat are based on personal encounters from 33 sites, as well as from consultation of vouchers through loans or sendings of duplicates from knowledgeable colleagues such as Bruce Sorrie (North Carolina) and Loran Anderson (Florida). The survey has resulted in re-establishment of it in Alabama, establishment of Georgia records, and extension of its known range to Mississippi. While efforts to locate it in South Carolina and eastern Louisiana have thus far not been successful, such should be continued since there is plenty of suitable habitat there. Thus, "suitable" habitat is discussed below.

The geographic distribution of *R. crinipes* as presently understood is rather remarkable. A general realization of it can come from a map of the southern Atlantic and Gulf Coastal Plains, on which *Chamaecyparis thyoides* (L.) B.S.P. (including *C. henryae*) is shown (Little, E.L., Atlas of United States Trees, Vol. I, Map 11-E. 1971) since most of the optimal sites are in, or are upstream or downstream from *Chamaecyparis* habitat. In my experience, *R. crinipes* is never far from clean, clear, active streams or in seeps directly by them. Such streams, generally a pale wine in color through tinting by acidic-humic seepage are mostly swift and well aerated. They run clear soon and recede quickly after rain when the watershed is healthy. They have distinctive and stable woody and herbaceous bank floras. They have clean, sandy or gravelly sandy bottoms and bars, these often underlain by lenses of gray clay with iron mottling which often are exposed in the swifter runs. They meander, thus cut deeply into steep slopes and deposit large bars of sands and gravels opposite cuts, these bars often of white sands freckled with rounded stones and pebbles of quartz, hardened clay, chert. On the steep sides large trees are often undercut by floodwater, and topple into the stream, often to create considerable "jams" and "dams" with their attendant accumulations of floodwash. In more level stretches, particularly as the valley broadens, sandy-gravelly-silty floodplain develop, these optimum sites for some "high" forest of *Chamaecyparis*, *Magnolia virginiana*, *Liquidambar*, *Fraxinus*, *Acer rubrum* (sometimes *Acer saccharum*), various "willow" oak, *Liriodendron*, etc. with *Cyrilla*, *Cliftonia* (southern part of range), various *Myrica*, *Ilex*, *Vaccinium*, thickets of *Arundinaria*, etc. in the understory. As one moves downstream and gradient is less, as floodplains broaden and channels deepen, the amount of good habitat for the rhynchospora becomes less. Within the range of a stream of this sort, the best clones of *R. crinipes* are in full sun or light shade along the narrow banks below cuts, on tails of bars, in seepage areas in cuts and broader banks, or on low, frequently temporarily washed islands. Most of my finds have been around bridgesites,

these of course cleared back to limit of road right-of-way to what is usually a dense vegetation under which the *rhynchospora* becomes quickly more scarce. Wading up and downstream from a bridge gives one a perspective on how the species maintains under natural conditions. In broader streams this sun plant has no problem, but along narrower stretches where a channel is N-S-oriented there is too much shade. In such situations the *rhynchospora* is usually found only where overstory trees have toppled to create openings. In these, over time, clumps of culms are toppled by flood, their bases buried by floodwash, their lower internodes lengthening, their lower nodes rooting and extensive clones thus form. Heavy flood washing may dislodge parts of clones, some re-lodging downstream. The phenology is broad since this species flowers and fruits as early as May and will continue to do so until frost; therefore over a long season an abundant supply of fruits is swept downstream. Most fragments and fruits are doubtless lost, others may survive for short periods in shaded stretches, but in such active streams many openings are formed or reformed and are ideal. I encountered a perhaps anomalous but yet very interesting situation when sampling a large clone on Escambia Creek, Escambia County, Alabama, northeast of Atmore (Kral 85234), where many of the toppled culms had many spikelets in which the fruits had germinated, some actually beginning to take root where fascicles were flat against a patina of slick sandy peat. This again shows a possibility for a remarkable adaptation.

Several other *Rhynchospora* do occur in and immediately around populations of *R. crinipes*, some already noted, such as *R. filifolia*, *R. glomerata*, but also *R. cephalantha*, *R. chalarocephala*, *R. corniculata*, *R. gracilentia*, *R. macrostachya* (in the northern range), *R. microcephala*, *R. nitens*, *R. variflora*. It may, in shaded bottoms, sometimes also be associated with such species of shaded bottoms as *R. caduca*, *R. decurrens*, *R. miliacea*, or *R. mixta* of distinctively different section. But none of these associates have the combination of features that allow as much adaptation to “temperamental” and dynamic blackwater stream habitat that this tenacious and deeper-rooted species has.

There are some other sedges and monocots that can deal well with such sites, most notably *Eleocharis olivacea*, *Scirpus etuberculatus*, *S. subterminalis*, *Orontium*, *Sparganium*, various *Juncus*, particularly *J. polycephalus*, the sedges and *Sparganium* often streaming in massive clones along bars and islands and in shoals. But none of these is better adapted.

I suggest that *R. crinipes* once had a wider distribution along some of the larger streams, since a wider channel would also admit more light, particularly if this was a braided system with many shoals and bars. But, since larger stream systems also have (or had) broader displays of quality trees along them, and since logging of such systems has been generally disas-

trous, consequent extremes of flooding and receding, accompanied by increased siltation and accelerated erosion have washed out or buried these sorts of plants. In short, the continuance of *R. crinipes* very much depends on careful management of adjacent forest and watershed.

An overview of watersheds themselves would show the best ones to be in longleaf pine-deciduous scrub oak, "yellow" sandhills or where, toward the coast (as in Florida, Alabama) streams issue from or flow through Sand pine-evergreen scrub. These systems are fed by seepage or springs, sometimes karst type. The pine-oak-hickory uplands grade downslope to progressively more mesic systems of pines, oaks, hickories and other hardwoods such as *Liriodendron*, *Liquidambar*, maple, downward to a *Fagus-Magnolia* (*grandifolia*)-*Acer saccharum* (southern subspecies) type, to the actual streambottoms where are higher silt fractions and *Chamaecyparis-Taxodium*-Virginia bay-Red maple-willow oaks-*Persea-Ilex-Liquidambar* etc. hold forth. It is significant that there are often cutoff meanders, but while these may have abundant sedges along them, *R. crinipes* does not persist long in such places; it has to be part of an actively combed and well aerated stream. The only areas where there seems to be some transition of type is in the Florida Panhandle where some small and comparatively slack streams are flowing into or out of cypress ponds or bogs in a pine flatwoods system (localities in Bay, Gulf, Liberty counties). In these places, particularly along "ditched" flow, *R. crinipes* can be very close to habitat of *R. harperi*, *R. curtissii*.

Vouchers from the 33 sites I have inspected as of 1995, together some sent by Dr. L. Anderson, Dr. M. LeLong, and Mr. B. Sorrie are cited below. Since most of the sites I have sampled had few plants, most of my collections are represented by but one or two specimens and few large sets were therefore made:

Specimens examined: U.S.A. ALABAMA. Baldwin Co.: N side Bay Minette Creek directly across from Buzbee Landing, at waters edge, 23 Jul 1993, *Howard Horne*, *s.n.* (USAM, VDB); peat-muck slicks and in shallows of branch of Perdido River by county 61 bridge, ca 10 mi E of Bay Minette, 26 Jul 1990, *R. Kral* 78170, first record re-establishing species for Alabama! (BM, BRCH, CM, CTB, FSU, GH, K, MICH, MO, MSC, NCU, NY, TEX, USCH, VDB); same site, 21 Aug 1993, *R. Kral* 83269 (VDB, VSC); gravel bars, along Major's Creek off cty 96, W of Rabun, 18 Aug. 1994, *R. Kral* 84088A (MO, MSC, VDB). Conecuh Co.: gravelly-sandy-silty bank of swift creek by gravel road 5.4 mi W of Range, 18 Sep 1993, *R. Kral* 83325 (MO, NCU, VDB, WIS); recollected from seep bank, same site, 6 Jun, 1995, *Kral* 84890 (NY, US, VDB, VPI). Escambia Co.: sandy-gravelly seeps and banks along Escambia Creek near I-65 crossing SW of Barnett Crossroads, 21 Aug 1993, *R. Kral* 83267 (GA, MO, NCU, NY, US, VDB); Co. 27 crossing of Escambia Creek ca 10 mi NE of Atmore; sandy gravelly seep banks along stream, 18 Sep 1993, *R. Kral* 83329 (VDB, WIS); and downstream 13 Jul 1995 (fruit germinating in spikelets on toppled culms!), *Kral* 85234 (CLEMS, CTB, GH, K, MICH, MO, MSC, NY, TENN, TEX, US, USCH, VDB, VPI, VSC, WAT, WILLI); sandy gravelly bar in Juniper Creek by Al 49, ca 4.9 mi N of Brewton, scarce (the "Juniper" is *Chamaecyparis*), 18 Aug 1994, *R.*

Kral 84070 (VDB); and abundant along tributary just N, 6 Jun 1995, *Kral* 84888 (BM, BRCH, FSU, GA, GH, KANU, MICH, MO, NCU, NY, TEX, VDB). **Mobile Co.:** bars and banks (bluff bases), also forming "islands" above sandy-gravelly shallows, Puppy Creek, N end of AL 217, ca 1 mi S its jct. with Prime Rd., WSW Citronelle above and below bridge. *Chamaecyparis* present, many toppled, 20 Sep. 1993, *R. Kral* 83374 (BRCH, CM, FSU, GH, MO, VDB); revisited 10 Jun 1995, *Kral* 84994 (ALU, K, MBM, MICH, NY, USCH, VDB). **Washington Co.:** shallows and sandy silty banks of Bassett Creek, cypress-gum-maple, just N of Chatom by US 43, *R. Kral* 78266 (BRCH, CM, CTB, FSU, GA, GH, MICH, MO, NCU, NY, TEX, US, VDB, VSC, WAT), revisited 10 Jun 1995, *Kral* 84998 (GH, KANU, MICH, MO, MSC, NCU, NY, TEX, US, USCH, VDB, WIS); seeps and shallows of coldwater stream 0.5 mi N of Cty 6 on US 43, 2.7 mi N of Sunflower, 10 Aug 1992, *R. Kral* 81313 (CLEMS, GA, GH, MBM, MICH, MO, NCU, NY, TENN, USCH, VDB, WIS); shoals and sandy silty banks of Taylor's Creek, above and below US 43 bridge, 3.4 mi S of Milry, forming large colonies, 10 Jun 1995, *R. Kral* 85000 (APSU, BM, BRCH, CLEMS, CM, CTB, FSU, GA, GH, K, KANU, MBM, MICH, MO, NCU, NY, TENN, TEX, UNA, US, USCH, VDB, VPI, VSC, WAT, WILLI, WIS). **FLORIDA.** **Bay Co.:** small boggy stream in slash pine-titi flats by FL 22, 7.8 mi W of Sandy Creek bridge, 20 Jul 1993, *R. Kral* 82861 (ASPU, BM, CM, CTB, FSU, GA, GH, K, KANU, MBM, MICH, NCU, NY, UNA, US, USCH, VDB). **Gulf Co.:** sandy silty banks and shallows of Wettapo Creek at FL 22 crossing ca 5 mi W of Wewahitchka, 20 Jul 1993, *R. Kral* 82857 (AKG, BRCH, GA, GH, KANU, MICH, MSC, NCU, VDB). **Liberty Co.:** sandy silty gravelly banks and shallows of Moccasin Creek, *Cyrilla-Nyssa-Taxodium*, Apalachicola Nat. Forest, SR 379, ultimately draining into Kennedy Creek. Abundant, 24 Aug 1995, *R. Kral* with A. Gholson 85600 (AKG, FSU, GH, MO, MSC, USCH, VDB); small stream near Larkin's Farm Rd. by Co. 379, just S of Alligator Creek, 24 Aug 1995, *R. Kral* with A. Gholson 85602 (AKG, FSU, GH, MO, MSC, USCH, VDB). **Santa Rosa Co.:** moist sandy loam of low left bank of Big Coldwater Creek (via canoe) ca 8 air mi NNE of Milton. New to Florida! 26 Jul 1986, L.C. Anderson 9827 (FSU, VDB); turf banks along East Fork of Big Coldwater Creek, 6.4 km above Tomahawk Landing, 22 Jul 1990, J.A. Churchill 90164 (VDB, sent from set by Dr. Churchill); sandy-peaty banks of spring fed stream, along Big Juniper Creek at FL 191 bridge 2 mi SW of Munson, ca. 18 mi NE Milton, Blackwater River SE, 20 Sep 1989, S.L. Orzell & E.L. Bridges 12443 (TEX, VDB, etc.); FL 191, SW of Munson 2.8 mi; seeps along Juniper Creek just above bridge, 19 Sep 1993, *R. Kral* 83353 (GH, NY, US, VDB); ca. 4.5 mi W of Munson at FL 4 crossing Coldwater Creek; sandy-gravelly seep banks along stream, 19 Sep 1993, *R. Kral* 83339 (GH, VDB). **GEORGIA.** **Marion/Talbot Cos.:** sandy silty gravelly banks and low cuts of Upatoi Creek, both sides (these from N side), GA 41 bridge, ca 4 mi S of Geneva and E of Juniper, suffering from cutting by DOT mowers, 13 Aug 1995, *R. Kral* 85554 (GA, GH, MICH, NY, US, VDB). **Montgomery Co.:** sprigs atop *Nyssa biflora* stumps in small stream just below beaverdam, bayhead by US 221, 7 mi N of Uvalda, full sun, scarce, stream slack and turbid, 12 Aug 1995, *R. Kral* 85506 (MICH, MO, VDB). **Toombs Co.:** sandy silty gravelly banks of Pendleton Creek, scarce, by GA 152 bridge, NE of Lyons, 9 Aug 1995, *R. Kral* 85428 (VDB); sandy silty gravelly banks of Pendleton Creek, scarce, at Wixtrum's Bridge, by GA 297, N of Vidalia below Interstate, 9 Aug 1995, *R. Kral* 85420 (TEX, USCH, VDB). **Treutlen Co.:** sandy silty gravelly banks and shallows, Red Bluff Creek by GA 29, NW of Soperton, scarce, first formal record for Georgia, 14 Jul 1994, *R. Kral* 83808 (CTB, FSU, GA, GH, NCU, VDB); sandy seep bank of Pendleton Creek, 0.5 mi S of I-16 by US 221; made scarce by DOT cutting, 12 Aug 1995, *R. Kral* 85505 (MO, VDB). **Wheeler Co.:** wet sands, silts and gravels of swift creek (Ochwatkee trib.) above and below GA 46 bridge in full sun and light shade, 9 Aug 1995, *R. Kral* 85409 (GA, GH,

NY, VDB, VSC). **MISSISSIPPI.** Greene Co.: peat-muck and sand of clear, flowing small stream through bay bottom in pine flats by MS 56, 17.7 mi S of State Line, 27 Aug 1991, first record for Mississippi, *R. Kral* 79807 (CTB, MICH, VDB); gravelly shallows of pine barren stream by MS 57, 11.3 mi S of State Line, 11 Aug 1992, *R. Kral* 81349 (CTB, MO, VDB); gravelly sandy silt of pine barren coldwater stream by MS 57, 15.7 mi S of State Line and 6.1 mi N jct. MS 63, 11 Aug 1992, *R. Kral* 81360 (CTB, GH, VDB); sandy gravelly seeps and shallows of coldwater pine barren stream by MS 57, 5.1 mi N of jct. MS 63 (Leaksville), 1 Aug 1992, *R. Kral* 81369 (VDB). **Jackson Co.:** bars and shallows, gravelly-silty-sand over clay, narrow of Bluff Creek, E side of MS 52 at S side of Van Cleave; large colonies, culms mostly toppled by flood, inundated spikelets looking black; *Chamaecyparis* present, 7 Jun 1995, *R. Kral* 84936 (BM, BRCH, CM, CTB, FSU, GA, GH, K, KANU, MBM, MICH, MO, MSC, NCU, NY, TENN, TEX, US, USCH, VDB, VPI, VSC, WILLI, WIS); sandy silty banks and shallows of small stream by MS 52, ca 5 mi S of George Co. line, occasional, some in full sun, some shaded by *Cyrilla*, 7 Jun 1995, *R. Kral* 84937 (CLEMS, GH, MO, VDB). **Wayne Co.:** Clara, SE of jct. MS 63 & Big Creek, T7N, R7W, S9, open area, on sandy soil in creek, swift flowing water, 1 Sep 1993, *C.T. Bryson* 12920 (CTB, VDB); gravelly shallows of clear, swift stream by MS 63, at Clara, near roadside park, 20 Sep 1993, *R. Kral* 83382 (CM, CTB, GA, GH, MICH, MS, MO, NCU, NY, TEX, US, USCH, VDB, VPI, VSC, WILLI, WIS). **NORTH CAROLINA.** Hoke Co.: Fort Bragg Military Reservation: semi-shady bank of Little River, stable Cretaceous clay soil, plants swept prostrate by flooding. First NC record! 27 Aug 1992, *B.A. Sorrie s.n.* (dupl. sent to VDB by Mr. Sorrie). **Moore Co.:** shallows and banks of swift flowing Buffalo Creek (trib. of Little River) by SR 1001 (Lobelia Rd.) 8.5 mi E of Vass, plants abundant this locality, 10 Aug 1993, *R. Kral* 82960 (FSU, GH, MICH, MO, MSC, NCU, NY, VDB—site given by B. Sorrie from his earlier record!).

Thus we now have several records from five southeastern states of a plant which, up until late 1989, was known only from two specimens, sketchily documented, collected by Dr. Mohr from Mobile Co., Alabama, and thought by many to be quite possibly extinct.

Two Georgia sites for *R. crinipes* were collected by Dr. John Bozeman but not so identified. In 1990, doing loans kindly sent by NCU and GA I was able to find and annotate them: **GEORGIA.** Appling Co.: Big Satilla Creek swamp on GA 99 at Bacon Co. line S of Baxley, 9 Jun 1967, *J. Bozeman* 9313 (NCU). Turner Co.: Little River swamp on Co. Rd. S1989 S of Sycamore and 1.9 mi W of US 41 at Anaha, 15 Jun 1967, *J. Bozeman* 9720 (GA, NCU). Both are excellent examples and provided incentive to relocate the populations. Attempts in 1991, 1992, 1993, and 1994 however failed. It must be said that the two Bozeman localities had suffered since the 1960s from heavy and destructive logging both in their immediate vicinity and in the surrounding watershed. Also, in the years since 1991, the history of weather has been one of extreme flooding alternating with extreme drought and heat during the growing season, making it difficult to visit the sites at an optimum time. But the condition of the bottoms and banks of the two stream systems, disturbed as they are, lead me to suggest that these two populations are extirpated.

5. ***Rhynchospora curtissii*** Britton ex Small, Fl. SE U.S. 195. 1903.

Phaeocephalum curtissii House, Amer. Midl. Naturalist 6:201. 1920. *Rhynchospora filifolia* A.Gray var. *ellipsoidea* Kük., Bot. Jahrb. Syst. 75:107. 1950. TYPE: FLORIDA. SANTA ROSA CO.: moist roadside, Milton, *Curtiss* 5929 (HOLOTYPE: NY; ISOTYPES: G, NCU, US).

R. fusca sensu Fernald, Bot. Gaz. 24:433. 1897, non (L.) W.T. Aiton.

Densely cespitose, e-rhizomatous, perennial 1–3(–4.8) dm high. Culms filiform, ascending to excurved, subterete, coarsely few-costate ca. 0.3–0.4 mm thick, leafy toward and at base. Leaves erect to ascending or excurved, filiform, the principal ones mostly 1–2 dm, the narrow, conduplicate sheaths terete, multicostate, the scarious ventral side apically transverse, the blades few-nerved, 0.2–0.3 mm wide, at base strongly involute, upblade scarcely tapered, canaliculate, slightly compressed or 2-edged, blunt apically. Terminal and penultimate fascicles usually compound, mostly narrowly turbinate to ellipsoid or oval, open or dense, the lower ones simple, of few (–1) spikelets, subtending bract linear-setaceous, exceeding lower fascicles, mostly exceeded by, rarely longer than terminal fascicle; spikelets lanceoloid, red-brown, 4.5–7 mm, narrowly acute; fruiting bracts mostly 2–5, narrowly oblong-ovate or elliptic, 3–4.5 mm, acute, mostly convex, only the midcosta evident, this short-excurrent as mucro or aristula; stipe and receptacle short, 0.1–0.2 mm, setose; perianth of 6, antrorsely barbellate, basally pilose bristles 3–3.7 mm, extending well past tubercle tip; stamens 2, anthers linear, ca. 2 mm; fruit body lenticular, narrowly oblong-obovate, 1.2–1.5 mm

margined, apically transversely troughed at junction with raised tubercle base, faces lustrous brown around a paler, usually glassy central disc, very finely lined longitudinally transversely with wavy lines of fine pits; mature tubercle triangular or slightly concave-sided, edges setulose. Figure 6.

Moist to wet sands and peats of bog edges, pineland pondshores, seeps and pine-cypress savanna, Atlantic and Gulf Coastal Plain, locally abundant, eastern North Carolina intermittently south through South Carolina, Georgia to northern Florida, west to western Florida, southern Alabama and Mississippi. Figure 3.

This low, wispy sedge forms dense tussocks as do *R. rariflora*, *R. oligantha*, and like them seems to prefer the black fine sandy peats of frequently burned, unbroken pine savanna or shallow bogs in that type. Like *R. oligantha* it becomes more scarce as virgin savanna is converted to field or improved pasture. Habitally it most resembles *R. pleiantha* but of course lacks the rhizomes; ecologically however, it is in quite another system and borders more on habitat occupied by *R. harperi*, *R. filifolia* of the complex.

Specimens examined: As previously, I am citing only VDB vouchers and some recent distributions: U.S.A. FLORIDA: Bay Co.: 1/2 mi W Youngstown on exposed wet sands

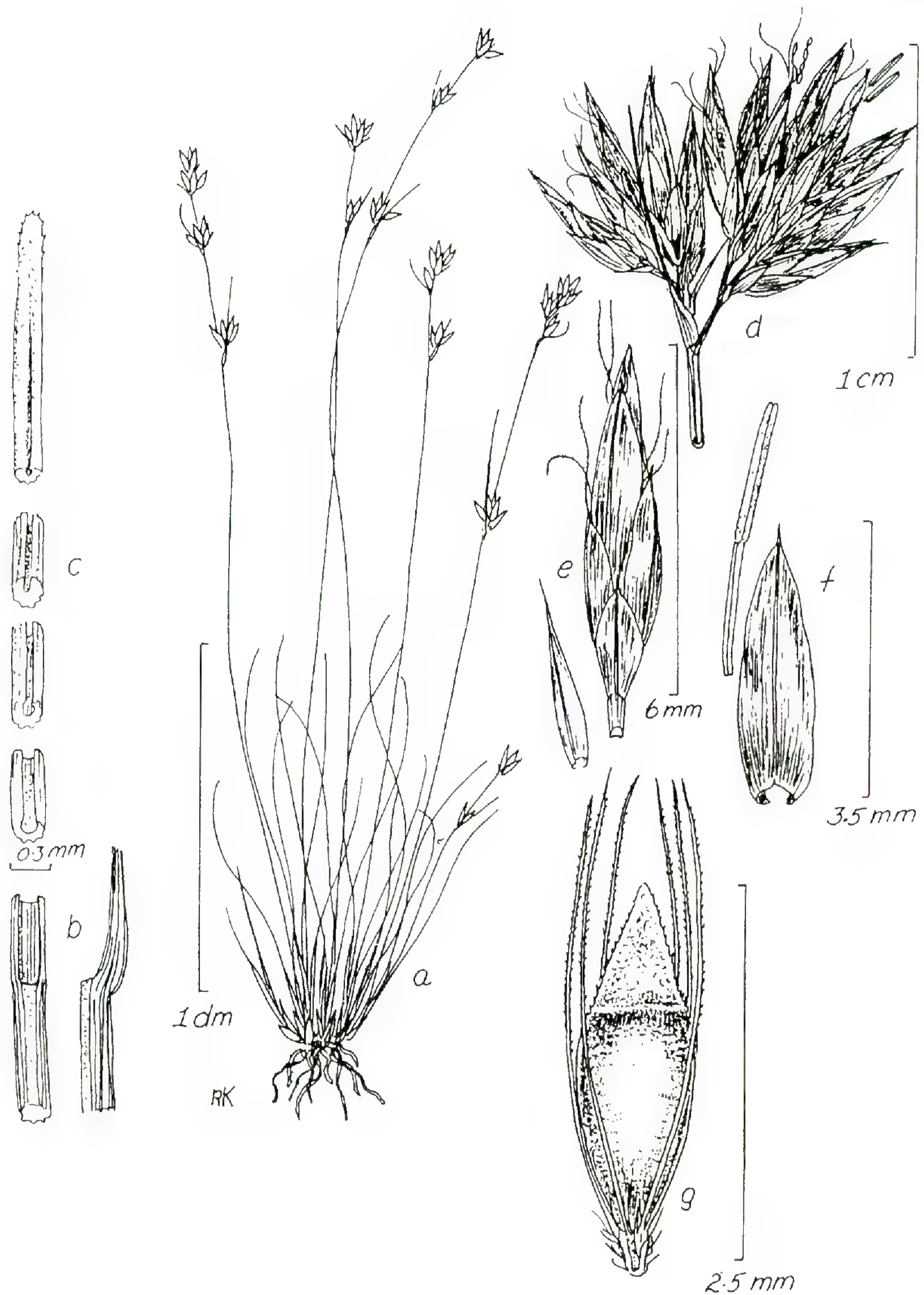


FIG. 6. *Rhynchospora curtissii* (Kral 7197). A. Habit sketch. B. Leaf sheath-blade junction, adaxial view (left), side view (right). C. Leaf blade sectors from base (bottom) to apex (top). D. Terminal fascicle complex. E. Spikelet with (left) subtending bract. F. Fertile scale, stamen apex with anther (right). G. Face view of mature fruit.

of seepage bog, 18 Aug 1962, *R. Kral* 15665 (VDB). **Escambia Co.:** 1 miles S jct. US 90 and co 289A W of Pensacola; sandy peat of pine flatwoods, 7 Jul 1963, *R. Kral* 17626 (VDB). **Franklin Co.:** 4.5 mi S on FL 65 from jct. with Fort Gadsden Creek, frequent, 31 May 1990, *S. & G. Jones* 5127 (TAES, VDB); pine flatwoods, 3 mi N of Eastpoint, 21 Jun 1965, *R. K. Godfrey* 65859 (FSU, VDB) sandy peat at edge of small cypress dome in scrub, end of shell road, East Point, ENE end of FL 65, 20 Jul 1993, *R. Kral* 82845 with *G. Moore* (BRCH, MICH, OSC, PH, SMU, VDB). **Gulf Co.:** wet peaty soil at margin of gum pond, 7 mi S of Wewahitchka, 18 Jun 1958, *R.K. Godfrey* 57091 (FSU, VDB); wet ditch, bordering pine flatwoods, 2.5 mi E of Port Saint Joe, 18 Jun 1958, *R.K. Godfrey* 57120 (FSU, VDB); N side White City; sandy peat of clearing in slash pine-palmetto flatwoods, 27 May 1979, *R. Kral* 63775 (VDB). **Liberty Co.:** sandy peaty soil, broad roadside ditch bordering pine flatwoods, 11.5 mi N of Sumatra, 14 Jun 1960, *R.K. Godfrey & J.N. Triplett* 59802 (FSU, VDB); sandy peat of bulldozed cypress-pine, FL 65, Telogia (undisturbed portion), 3 Jul 1993, *R. Kral* 82810 (CM, CTB, FSU, GA, GH, MBM, UNA, VDB). **Santa Rosa Co.:** common in wet sands of roadway across savanna, between I-10 and Milton, 24 Jul 1974, *R.K. Godfrey* 73791 (FSU, VDB); sandy peat of pine savanna by FL 191 exit off I-10 (Bagdad Exit), 29 Jun 1991, *R. Kral* 79282 (VDB & distribution); pine and cypress flats along Yellow River W of FL 87, N of Holley & S of I-10, sandy peat of wet savanna-like area, 27 Aug 1991, *R. Kral* 79782 (VDB & distribution); 4.5 mi E of Gulf Breeze, common on moist pine savanna, 11 Oct 1963, *S. McDaniel* 3862 (FSU, VDB). **Wakulla Co.:** sandy-peaty ditch bordering pine flatwoods, St. marks Wildlife Refuge, between Sopchoppy and Panacea, 9 Jun 1960, *R.K. Godfrey* 59705 (FSU, VDB); mesic longleaf pine / wiregrass - saw palmetto savanna on SW side of FS Rd 314-I at int of FS Rd 314-H, ca 0.4 mi NW int FH 13 at ca 2.4 mi NE of int FL 375, ca 1.6 mi NE of Smith Creek School, Apalachicola NF, 24 Jun 1990, *S.R. Orzell & E.L. Bridges* (TEX, VDB). **Walton Co.:** sandy peat of hillside seep in longleaf pine by FL 20, ca 7 mi W of Ebro, 29 Jun 1991, *R. Kral* 79290 (VDB & distribution). **Washington Co.:** N side of FL 20, 6.5 mi E of Ebro; sandy peat of low pine savanna, cypress-pine-titi, 26 Aug 1995, *R. Kral* 85623 (BM, CM, GH, K, MICH, MSC, NCU, NY, OS, VDB).

6. *Rhynchospora filifolia* A. Gray in Torrey, Ann. Lyceum Nat. Hist. New York 3:366. 1836. *Phaeocephalum filifolium* (Gray) House, Amer. Midl. Naturalist 181. 1920. TYPE: U.S.A. NORTH CAROLINA [without county, annotated in Gray's hand (HOLOTYPE: NY, lectotypified by Gale (1944)).

Cespitose e-rhizomatous perennial (1–)2–8(–10) dm high. Culms filiform, wiry, mostly excurved or arching, obtuseangled to subterete, 0.3–0.7(–1.2) mm thick, coarsely few-costate, leafiest at and toward base. Leaves erect, ascending or excurved, principal ones 1–ca. 2 dm long, blades filiform, mostly 0.2–0.5 mm wide (broadest ones actually bracteal and to 2 mm wide), proximally flattened or broadly “V”-shaped to slightly involute, finely nerved but with midcosta strongly raised abaxially, upblade strongly narrowed, progressively more deeply canaliculate and filiform, becoming unisulcate, thickened, the very apex thick, blunt, but with scabrid edges. Fascicles of spikelets mostly compound, 1–3(–4), sparse to dense, narrowly turbinate or even short-cylindric to hemispheric, often lobed, 0.7–1.5 x 0.7–1.5 cm, the terminal one well exceeded by at least 1 subulate-setaceous bract, the lower ones progressively longer peduncled, peduncles erect

or excurved, subtended by progressively longer, leafier bracts. Spikelets ovoid to lanceoloid, 2.5–3.5 mm, narrowly acute; scales several, the fertile ones 2–3(–4), ovate, 2–2.5 mm, acute, convex, only the strong midcosta evident, this usually excurrent as a mucro or arista; stipe and receptacle stout, ca. 0.2–0.3 mm, sparsely to densely setose and setulose; perianth of 6 antrorsely scabrid bristles 1.5–2 mm long; fruit body mostly broadly obovoid, 0.8–1 mm, lenticular, margined, faces light to deep brown, lustrous, finely longitudinally lined, sometimes very finely cancellate and with wavy lines of small pits, but always with a strongly contrasting pale, glassy center; tubercle triangular 0.5–0.7 mm, its edges variably setulose-scabrid, base shallowly lunate, slightly decurrent. Figure 7.

Moist to wet sands, sandy peats or peat of grass-sedge meadow, pine savanna, seeps and bogs, pondshores, ditches, streambanks and bars, pine flatwoods, Atlantic and Gulf Coastal Plain, and contiguous physiology, New Jersey south to southern Florida, then westward to eastern Texas; Greater Antilles, Mesoamerica. Figure 8.

This species is the most ample ecologically of the species treated here, which doubtless explains its highly variable habit as well as its occurrence within the habitat of all of these taxa. But as regards its inflorescence, inflorescence bracts, spikelet color and dimension, perianth and fruit the many hundreds of specimens examined in this study are remarkably consistent; the bracts consistently exceed inflorescences; the spikelets are the shortest, often of broadest outline but with fewer fertile scales, these the shortest and broadest in outline; the fruit bodies are the shortest, distinctly the smoothest, always with the glassy pale central “disc” on each face. It is, as one would suspect, the weediest of the species, is a quick invader of disturbed wetland sites so long as they remain undrained. Sometimes, in a single savanna in southern Alabama or northern Florida, it can present a considerable range of morphs, the moister or shadier situations having the taller, broader-leaved individuals, the more exposed or slightly drier sites with the shorter, narrower culmed-and-leaved individuals, these also often with the more sparsely spikeleted fascicles.

A review of the literature available on *R. filifolia* if followed by an examination of many specimens over the range, will show that Dr. Gale’s taxonomic disposition appears to be closer to the real situation than is that of Dr. Kükenenthal.

Since even a recording of specimens available here at VDB would be very lengthy, and since this distinctive species varies so little as to key characters, complete citations are not included here. Duplicates of many of my sets have been distributed as follows:

Representative specimens: U.S.A. ALABAMA. Baldwin Co.: *Kral* 85310 (APSU, BM, CM, CTB, F, FLAS, FSU, GA, GH, K, MICH, VDB). Covington Co.: *Kral* 84588 (BRCH,

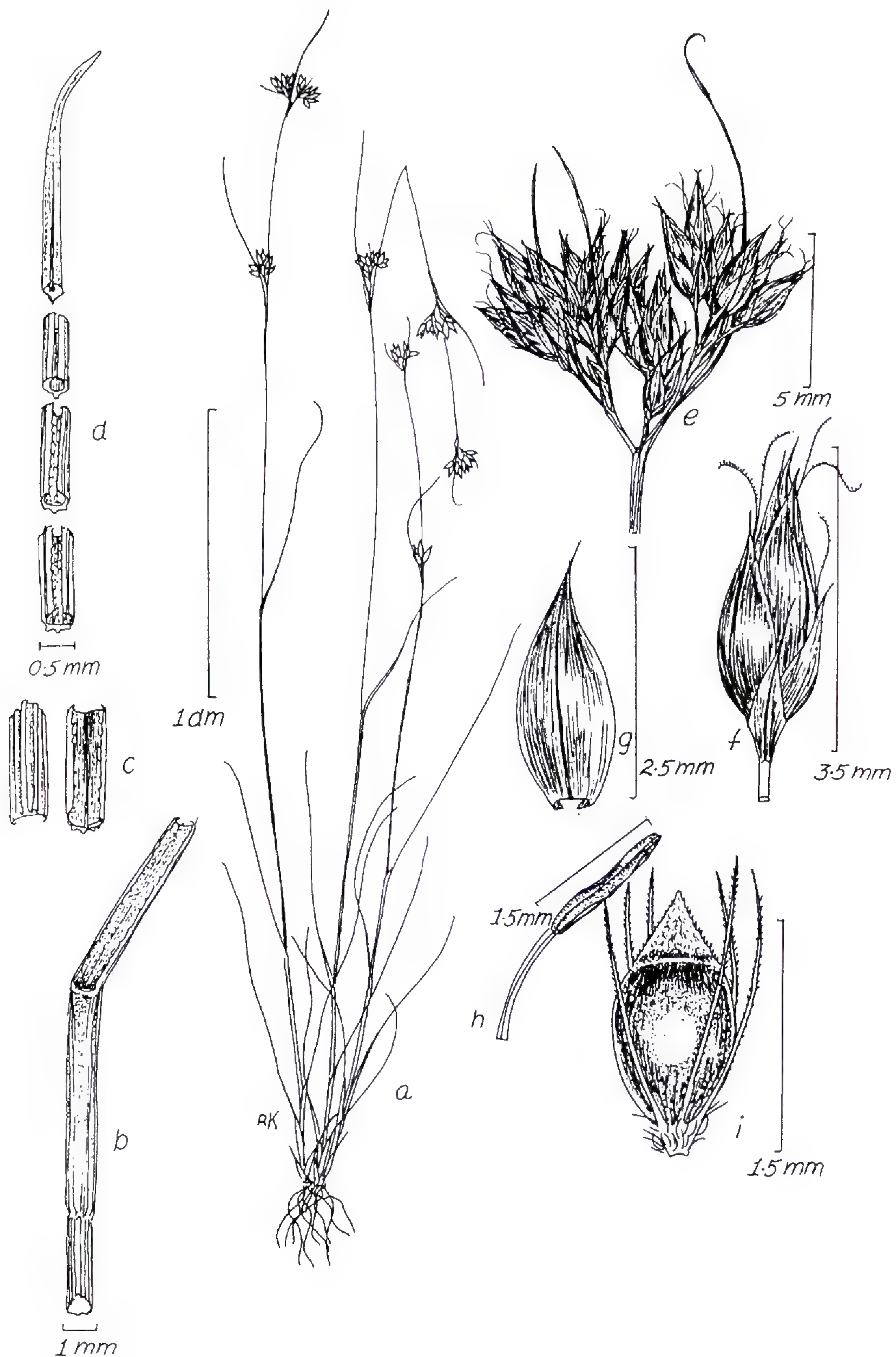


FIG. 7. *Rhynchospora filifolia* (Kral 39457, 79671). A. Habit sketch. B. Leaf sheath-blade junction, adaxial side. C. Leaf blade base sectors, abaxial side (left), adaxial side (right). D. Sectors of leaf blade, proximal end (bottom) to apex (top). E. Terminal spikelet complex. F. Spikelet. G. Fertile bract. H.—Filament apex with anther. I. Face view of mature fruit.

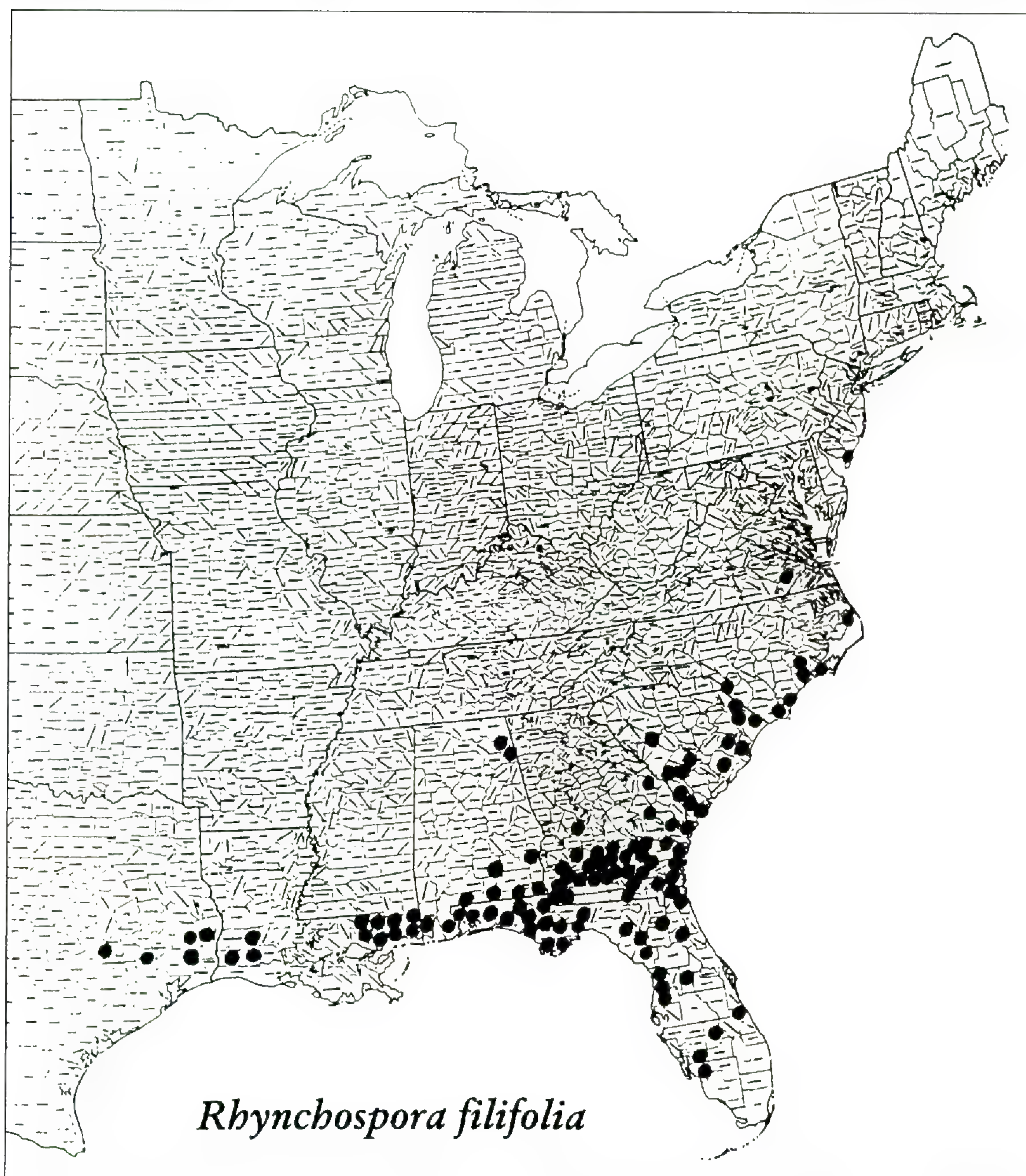


FIG. 8. Distribution of *Rhynchospora filifolia* in the southeastern United States.

NY, OS, TEX, VDB). Crenshaw Co.: *Kral* 82940 (NLU, NY, SMU, UNA, VDB). Escambia Co.: *Kral* 84913 (MO, MSC, MU, VDB). Geneva Co.: *Kral* 81167 (GH, MO, VDB); *Kral* 84859 (FSU, USCH, VDB). Houston Co.: *Kral* 81156 (BRCH, NY, SMU, VDB); 81111 (BRCH, MO, NY, SMU, VDB); 81131 (CTB, GH, VDB). Mobile Co.: *Kral* 81493 (GH, VDB); 81488 (FSU, MSC); 81469 (GH, KANU, MICH, MO, TENN, VDB). FLORIDA. Bay Co.: *Kral* 82862 (GH, IBE, MICH, MO, VDB); 84613 (BRCH, TEX, VDB, VPI); 84616 (FLAS, FSU, GA, GH, K, MICH, MO, MSC, MU, NCU, NY, OS, VDB); 84617 (APSU, BM, CM, CTB, F). Franklin Co.: *Kral* 82801 (BRCH, CM, CTB, GA, GH, IBE, MBM, MICH, MO, NCS, NCU, NLU, NY, SMU, TENN, VDB); 82880 (GH, MO, SMU, VSC). Gulf Co.: *Kral* 82854B (IBE, SMU); 84605 (FSU, GH, K, MO, USCH, VDB). Okaloosa Co.: *Kral* 84563 (MSC, MU, NCU, NY, VDB). Wakulla Co.: *Kral* 82763 (CM, CTB, GA, VDB). Washington Co.: *Kral* 82839 (CM, CTB, UNA,

VDB). GEORGIA. Appling Co.: *Kral* 83127 (CM, GA, MO, NCU, NLU, NY, VDB). Bacon Co.: *Kral* 82714 (CM, CTB, FSU, GA, GH, IBE, MICH, MO, NCU, NY, SMU, VDB). Ben Hill Co.: *Kral* 83970 (NCU, VDB). Berrien Co.: *Kral* 80706 (CTB, GH, TENN, VDB). Emanuel Co.: *Kral* 85460 (BRCH, TEX, USCH, VDB). Glynn Co.: *Kral* 83081 (GA, GH, MICH, MO, TENN, VDB). Irwin Co.: *Kral* 80920 (GH, MO, VDB). Jeff Davies Co.: *Kral* 83181 (GA, GH, MBM). Long Co.: *Kral* 83105 (GA, GH, SMU, VDB). McIntosh Co.: *Kral* 83064 (GA, GH, VDB). Tift Co.: *Kral* 80893 (GH, VDB, VSC). Turner Co.: *Kral* 82684 (GA, MO, VDB). LOUISIANA. Washington Par.: *Kral* 84947 (GH, MO, NY, OS). MISSISSIPPI. Jackson Co.: *Kral* 81432 (GH, VDB); 81457 (BRCH, CH, CTB, FSU, GA, GH, KANU, MICH, MISSA, MO, MU, NY, OSH, SMU, TENN, VDB, VSC, WIS); 81460 (GA, MO, VDB); 81461 (BRCH, MU, OSH, SMU, VDB, WIS) 84963 (TEX, VDB, VPI, VSC; 84940 (GH, VDB); 85302 (GH, MICH, MO, VDB). Pearl River Co.: *Kral* 85279 (MICH, MO). SOUTH CAROLINA. Berkeley Co.: *Kral* 83028 (BRCH, FSU, VDB); 83031 (IBE, MICH, MO, NCS, NCU, VDB)

ACKNOWLEDGMENTS

My own interest in *Rhynchospora* dates from trying to make sense of my collections of such plants in Alabama so as to do a reasonable treatment for that State Flora. The "courage of my confusions" (to paraphrase from Lyman Benson) led to a yet unpublished treatment, further to undertaking to do the genus for FNA, this since the early 1990s in the hands of those editors. In the course of such work curators and staffs of the following institutions (cited by acronym) were kind to extend loans or to allow visits: A, BRIT-SMU BH, CTB, FSU, GH, KANU, MICH, MO, MU, NCU, NLU, NY, RM, SD, TAES, TEX, UC, US, USC, USCH, VKPI, VSC, WILLI. Such aid is gratefully acknowledged as is that from others knowledgeable in the genus such as Dr. C.T. Bryson, Dr. R.K. Godfrey, Richard LeBlond and Bruce A. Sorrie. Fieldwork on the genus and on *R. crinipes* in particular was in large part supported through a contract to do a status survey of *Rhynchospora crinipes* awarded beginning 1990 through the kindness of Ms. Cary Norquist of the Jackson Mississippi office, U.S. Department of the Interior, and administered by Mr. Scott C. Gunn and subsequently by Ms. Jarel T. Hilton of the Alabama Natural Heritage Program, Montgomery. The final draft of the *R. crinipes* status report was submitted October 1995.

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BOOK NOTICE

SILVERTHORNE, ELIZABETH. 1996. **Legends & Lore of Texas Wildflowers.** (ISBN 0-89096-702-4, hbk.) Texas A&M University Press, Drawer C, College Station, Texas 77843-4354, \$29.95. 264 pp, 18 b&w illustrations.

For those of us that spend countless hours splitting botanical hairs—it would be a pleasant respite to sit down in front of a warm winter fire with a comforting cup of tea and this book. Folklore enthusiasts, gardeners, and Texas history buffs can browse the forty-four chapters set aside for each Texas wildflower that the author has found the most fascinating.

Elizabeth Silverthorne admits she is not a botanist or certified naturalist but has a deep interest in wildflowers and mythology. In this book she keeps alive the 'telling of the tale' of Texas wildflowers along with their natural, political and social history.

I particularly found the wildflower mythology of interest. As with all mythology it is simple and forceful and transcends things unexplainable as in one passage in the chapter on Clover ... "according to tradition it was instrumental in persuading the Irish people to accept the Christian faith: As St. Patrick labored during the early days of his mission to explain the doctrine of the trinity to a clan of dubious natives, he had little success. Then one day a chieftain demanded, 'How can there be three in one?' and St. Patrick, noticing the shamrocks growing at his feet, plucked one leaf and held it up. Using this old lucky symbol of the sacred sun wheel, he illustrated how three persons in the Godhead can exist and yet be one. The illustration was so simple and so forceful that the entire clan followed its leaders in accepting Christianity."

Legends & Lore of Texas Wildflowers is the tenth book by this award-winning author who resides in Salado, Texas.—*Linny Heagy.*

TWO NEW COMBINATIONS IN *ELEOCHARIS* (CYPERACEAE)

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ABSTRACT

During a study of *Eleocharis* section *Pauciflorae*, and other species thought to be related, it became apparent that some nomenclatural changes were necessary. Two new combinations are proposed: *Eleocharis albibracteata* var. *boliviana* and *E. quinqueflora* var. *bernardina*.

RESUMEN

Durante el estudio de *Eleocharis* sección *Pauciflorae*, y de otras especies al parecer relacionadas, se detectó la necesidad de llevar a cabo cambios nomenclaturales. Son propuestas aquí dos combinaciones nuevas: *Eleocharis albibracteata* var. *boliviana* y *Eleocharis quinqueflora* var. *bernardina*.

Eleocharis R. Br. is a widely distributed genus of about 200 recognized species among its approximately 600 published names. The genus is receiving increasing attention because of the potential use of several species in aquatic weed management and in pollution abatement (Catling & Hay 1993). *Eleocharis* is morphologically uniform and has the following diagnostic features: inflorescence reduced to one spikelet, leaves reduced to tubular basal sheaths, and base of style persistent as a tubercle. Despite its morphological simplicity, a wide diversity of species groups have been recognized historically.

In the course of preparing a revised infrageneric classification of *Eleocharis* (González-Elizondo and Peterson, unpubl. data) and while working on a cladistic-phenetic analysis of section *Pauciflorae* (González-Elizondo et al. in press), it became apparent to us that two combinations were needed. A phenetic analysis of the species historically placed in *Eleocharis* section *Pauciflorae*, supports the recognition of *E. boliviana* Palla ex Svenson as a variety of *E. albibracteata* Nees & Meyen ex Kunth (González-Elizondo et

al. in press). Another combination is necessary to place *E. pauciflora* (Lightf.) Link var. *bernardina* (Munz & I. M. Johnston) Svenson in *E. quinqueflora* (Hartmann) Schwarz, the currently accepted name for the species. The two new combinations are given below.

1. *Eleocharis albibracteata* Nees & Meyen ex Kunth var. *boliviana* (Palla ex Svenson) S. González & P. M. Peterson, comb. et stat. nov. *E. boliviana* Palla ex Svenson, *Rhodora* 31:179. 1929. TYPE: BOLIVIA. La Paz, 3750 m, 1 Jan 1919, O. Buchtien 4482 (GH!).

Eleocharis boliviana (subgenus *Eleocharis* section *Eleocharis* series *Eleocharis* subseries *Truncatae*) was considered by Svenson (1929) as close to *E. albibracteata*, differing in "larger stature, paler spikelets, and more sharply angled achene, with less conspicuous reticulation and much narrower style-base." Comparison of the type of *E. boliviana* with specimens of the uncommon but widely distributed *E. albibracteata* showed that *E. boliviana* has relatively taller and thicker culms in separate fascicles on a long rhizome, and slightly narrower, prominently angled achenes. In all other aspects it is similar to *E. albibracteata*. Both species showed a very low intra-cluster phenetic distance in an analysis (González-Elizondo et al. in press), reflecting similar morphologies. These differences are not used at the species level by us and we prefer to treat *E. boliviana* at the variety level under *E. albibracteata*.

Representative specimens (all in US). Bolivia: 10 Aug 1901, *R.S. Williams* 2571; Andean Region, 4,000 m., *E. Asplund* 6398; Ecuador: *W. Jameson* s.n (US 534868).

2. *Eleocharis quinqueflora* (Hartmann) Schwarz var. *bernardina* (Munz & I.M. Johnston) S. González & P. M. Peterson, comb. nov. *Scirpus bernardinus* Munz & I.M. Johnston, *Bull. Torrey Bot. Club* 52:221. 1925. *Eleocharis bernardina* (Munz & I.M. Johnston) Munz & I.M. Johnston in Munz, *Man. S. Calif. Bot.* 68, 597. 1935. *Eleocharis pauciflora* (Lightf.) Link var. *bernardina* (Munz & I. M. Johnston) Svenson, *Rhodora* 31:174. 1929. TYPE: U.S.A. CALIFORNIA. SAN BERNARDINO CO.: South Fork of Santa Ana River, 8500 ft, *P.A. Munz* 6187 (POM!).

Eleocharis bernardinus (*Eleocharis* subgenus *Zinserlingia* section *Pauciflorae*) was reduced to a variety of *E. pauciflora* by Svenson (1929) and was later treated as a synonym of *E. pauciflora* (Svenson 1957). It differs from the typical *E. quinqueflora* (= *E. pauciflora*) by having thicker rootstocks, darker glumes with the lowermost usually sterile (often fertile in var. *quinqueflora*), obovoid achenes (narrowly obovoid in var. *quinqueflora*), high-conic tubercles, and rounded upper sheath apices that are sub-membranous (often oblique, acute, and ± firm in var. *quinqueflora*). Despite these differences, we consider the varietal rank adequate recognition since morphologically intermediate specimens have been made in Gunnison County, Colorado (1/4 mi SE of Gothic, 9,600 ft, 19 Jul 1959, *J. Barrell* 91-59, US!; Copley Lake, 2 or 3 mi NE of Kebler Pass, 16 Jul 1960, *J. Barrell* 116-60, US!).

Representative specimens (all in US). **U.S.A. Mono Co.:** Summit of Dana Plateau, vicinity of Mount Dana, 12,000 ft, 15 Jul 1937, *C.W. Sharsmith* 2478. **CALIFORNIA. San Bernardino Co.:** South Fork of Santa Ana River, 8,500 ft, 26 Jul 1926, *P. A. Munz* 10804 (topotype). **Tulare Co.:** John Muir Trail w of Center Peak, 10, 500 ft, 30 Jul 1948, *J.T. Howell* 25196.

ACKNOWLEDGMENTS

John F. Pruski and Harold Robinson are thanked for reviewing the manuscript and Victoria E. Batista is thanked for revising the Spanish abstract.

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BOOK NOTICE

WELCH, WILLIAM C. and GREG GRANT. 1995. **The Southern Heirloom Garden.** (ISBN 0-87833-877-2, hbk.) Taylor Publishing Company, 1550 West Mockingbird Lane, Dallas, Texas 75235, (214) 819-8100, \$29.95. 200 pp.

An essential book, not just for gardeners but for historians as well, especially those of us who have longed for a trip back in time to visit with our great grandparents for advice on how to tend our gardens. Though our ancestors are now silent, they live on in the legacy of plants they nourished—plants still thriving today in the southern garden and *The Southern Heirloom Garden* is their voice.

Looking beyond the obvious to the ancestral 'bones' of a southern garden, the authors show us how the many diverse cultures sowed their own seeds of gardening acumen and created these ethnic gardens. In time they blended into a horticultural heritage that is uniquely North American. Welch and Grant give us lists of plants and techniques on their culture and how to landscape heirloom gardens (practical advice you don't find on growers tags at nurseries.) Explanations of Latin names placed throughout the text rather than in a separate chapter, is a good way of educating the lay person on scientific aspects without intimidating. On the contrary, it draws the garden lover into how definitive Latin/Greek names are and makes them less formidable. Text is spiced here and there with observations such as: [Regarding the shrub *Arborvitae*] ... 'Some plants don't deserve all the grief we give them. Like I tell my mamma about our "occasional" undesirable relatives and ancestors; you can't hide from your true heritage. And if you didn't know who they were, you might even like them. She doesn't buy that, though.'

The book is divided into three sections: Restoring Southern Gardens; eight chapters of the various cultures that influenced southern gardens: Native American, Spanish, French, African-American, English and German; a list of 67 heirloom plants of the south and resources for purchasing southern heirloom plants. Climatic zone requirements are listed on each plant along with a corresponding map.

The cropping and design techniques used on some of the photographs are a bit heavy handed. It's a shame the photographs are not just left alone. Overall, the design of the book does not do the content as much justice as it deserves, but read on anyway, it's worth it.—*Linny Heagy*.

A NEW, DISJUNCT VARIETY OF *SPIGELIA GENTIANOIDES* (LOGANIACEAE) FROM BIBB COUNTY, ALABAMA

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ABSTRACT

A new variety of an endangered plant species, *Spigelia gentianoides* (Loganiaceae), is described. The new variety, differing largely in quantitative features, comprises a group of recently discovered populations in central Alabama, well disjunct from the type variety of central Florida. The new populations are localized to a rare glade community of Ketona dolomite on the Little Cahaba River and contain greater numbers of individuals than any of the Florida populations.

KEY WORDS: *Spigelia*, *Spigelia gentianoides*, Loganiaceae, disjunct, Alabama, endangered species

RESUMEN

Se describe una nueva variedad de una especie vegetal en peligro, *Spigelia gentianoides* (Loganiaceae). La nueva variedad comprende unas poblaciones descubiertas en el centro del estado de Alabama, separadas geográficamente de la variedad típica, que está restringida al estado de Florida. Las nuevas poblaciones se localizan en una comunidad tipo "glade," con abundancia de rocas dolomíticas de la formación Ketona, en el río Little Cahaba. Esta población contiene muchos más individuos que cualquier población de Florida.

A new, disjunct group of populations of the Federally Endangered *Spigelia gentianoides* (Loganiaceae) was discovered in 1992 by James R. Allison of the Georgia Natural Heritage Program, Georgia Department of Natural Resources, while exploring the Little Cahaba River in Bibb County, central Alabama. This *Spigelia* species was previously known only from several counties in the Florida panhandle, where it is believed to be near extinction from habitat loss (Kral 1983; Rogers 1986; A. Gholson, pers. comm.).

The Alabamian *Spigelia gentianoides* is found in association with many other rare plants, new species and new varieties of plants in a unique dolomitic glade community known as the Ketona Glades, which encompasses over 40 outcrops of Upper Cambrian dolomite (Allison 1994a, 1994b). These populations are not only geographically isolated from the Florida populations, but their individuals also exhibit trait differences that signify

genetic differentiation from the Florida plants. Thus the Alabama populations of *Spigelia gentianoides* are here described as a new variety.

***Spigelia gentianoides* Chapman ex A. DC. var. *alabamensis* K. Gould, var. nov. (Fig. 1)**

Similis *Spigeliae gentianoidi* var. *gentianoides* sea floribus majoribus, lobis corollarum patulis per anthesin, sepalis longioribus, cymis plerumque brevioribus, foliis lanceolatis aut ellipticis.

Perennial herb to 25 cm tall. Stems usually several from the underground rhizome, or of one main stem branching near the base, quadrangular, glabrous except at the nodes and ribs just below the nodes where scabrous. Interpetiolar stipules minute, membranaceous. *Leaves* opposite, none in pseudowhorls below the inflorescence, sessile, *mostly lanceolate to elliptic*, occasionally ovate to obovate, the mid-stem leaves 2.8–3.5 cm long, 0.8–1.9 cm wide, longer than the internodes, the upper bracteate leaves smaller, 1.6–1.9 cm long, 0.4–0.5 cm wide, the lowermost cauline leaves more orbicular and smaller; the blades mostly acute to acuminate at the apex, cuneate to rounded at the base, coriaceous, scarcely scabrous above, scabrous on the margins and veins beneath. *Inflorescence a terminal 2–4(–6) flowered cyme*, the peduncles 1–4 mm long, the bracts subulate, glabrous, 3 mm long, the pedicels 2 mm long. Flowers 5-merous; *sepals* subulate, tending to be of unequal length, 8–11 mm long at anthesis, accrescent to 12 mm long and exceeding the mature capsule at maturity, the tips acute, the margins and midvein scabrous; *corolla broadly funnelform* with plicate lobes, fleshy, light pink outside with a green tinge at the base of the tube, two darker pink vertical lines on each lobe, lighter pink to white inside, 36–50 mm long, the throat 8–15 mm wide, the free portion of the lobes ovate, acute, 12–13 mm long, with scabrous margins, *the lobes spreading open at anthesis*; stamens and style included; stamens epipetalous, borne 12–16 mm above the corolla base, the free filament 2 mm long, projecting inwards, the anthers 2–3 mm long, connivent around the style 1–2 mm below the stigmatic surface and dehiscing onto the pubescent portion of the style; pistil 24–27 mm long, the ovary globose, 1–2 mm long, green, glabrous, the style white to yellow, slender, 23–25 mm long, pubescent along the upper 6–9 mm, articulated 5–6 mm above the ovary, the stigma terminal, truncate to rounded, yellow, pubescent, less than 1 mm wide. Capsule bilobed, slightly crested on the top, glabrous, green, 8 mm high, 6 mm wide, the persistent style segment erect, dark brown, 5–6 mm long, the persistent, subtending fruit base white, 6 mm long with emarginate tips.

TYPE: ALABAMA. BIBB CO.: large Ketona dolomite glade on hillside above the Little Cahaba River from County Road 65, off Hwy. 25, 30 May 1996, *Katherine Gould* 145 with Sheryl Gould (HOLOTYPE: TEX; ISOTYPES: FLAS, FSU, GA, GH, UNA).

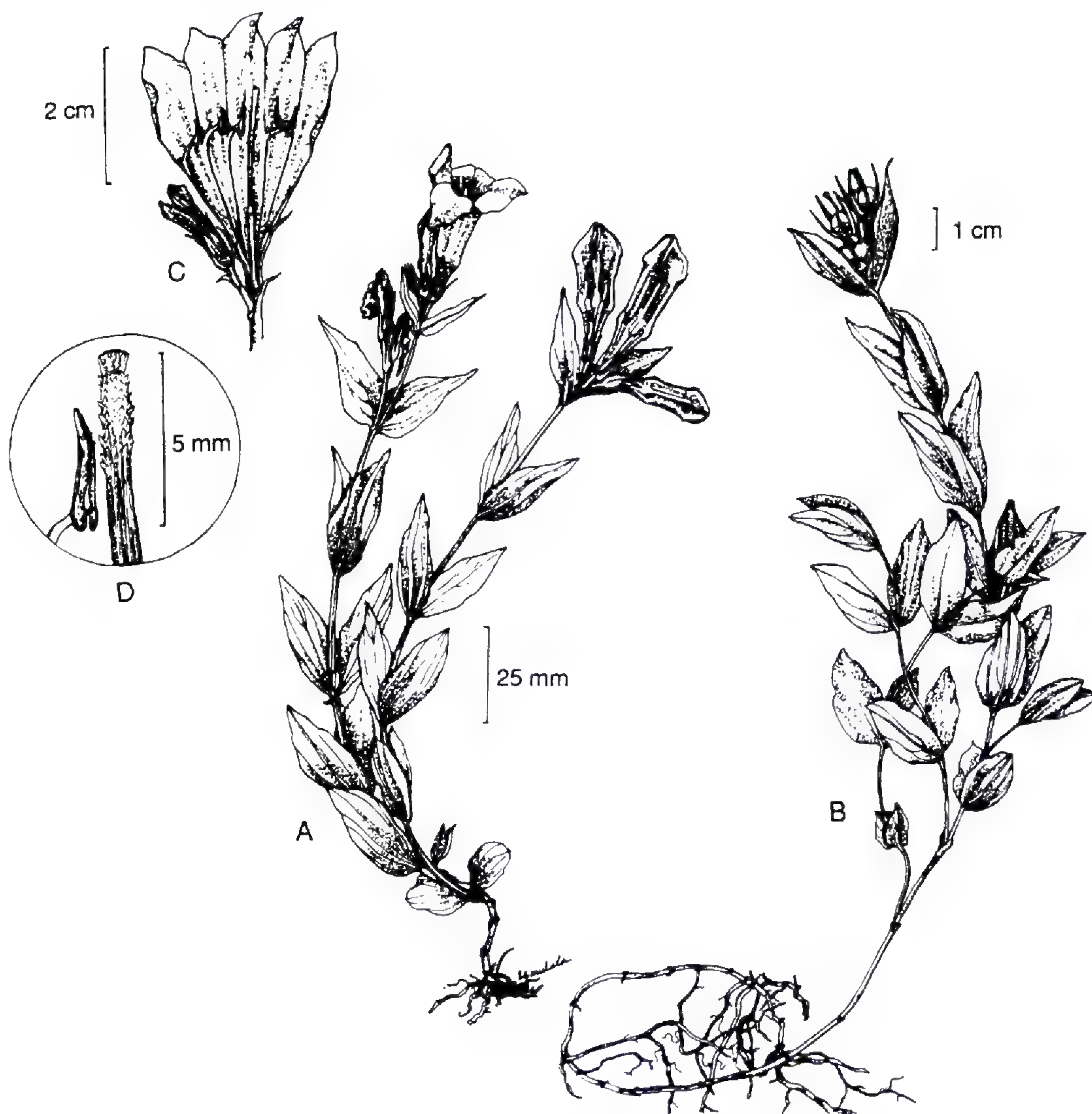


FIG. 1. A. *Spigelia gentianoides* var. *alabamensis*, habit, flowering plant. B. fruiting plant. C. mature flower, corolla cut open longitudinally to reveal stamens and pistil. D. upper portion of style and stigma showing relative anther position.

Additional specimens examined: Bibb Co.: N & E of Centreville [sic], dry, shallow soil accumulations on limestone outcrop, 1 Jun 1992, *Allison* 6688; Co. Rd. 65, 0.6 mi NW of Little Cahaba R[iver] bridge at Bull Dog Bend, 0.25 mi S on dirt road to river, 0.2 mi downstream, 33°03'33"N, 87°02'10"W, elev. 280 ft, 11 Jun 1995, *Ginzburg* 990 (UNA).

The most obvious difference between the two varieties is flower size: *Spigelia gentianoides* var. *alabamensis* has consistently longer corollas (36–50 mm vs. 25–30 mm) with broader throats (8–15 mm vs. 7–8 mm), longer lobes (12–13 mm vs. 5–7 mm), longer pistils (24–27 mm vs. 17–19 mm), and longer sepals (8–11 mm vs. 4–6 mm). Furthermore, var. *alabamensis* generally produces shorter inflorescences than var. *gentianoides* (2–4 flowers vs. 3–8). The overall appearance of the flowers in the two taxa is the same, except that the flowers of var. *gentianoides* barely open when mature, thus

appearing cleistogamous, while the flowers of var. *alabamensis* open fully at maturity, with their corolla lobes reflexing.

Leaf shape, though variable, tends to differ between the two populations: var. *gentianoides* has leaves that are more broadly ovate with rounded bases, whereas var. *alabamensis* produces leaves that are more lanceolate to elliptic, less frequently narrowly ovate, ovate or obovate, and with cuneate to rounded bases. Overall stem leaf size is the same between the two varieties.

Other qualitative and quantitative traits differing between the two varieties *in situ*, such as plant height, internode length, branching frequency, leaf and stem texture and leaf orientation, may be induced by environmental conditions, such as degree of sun exposure and differences in soil composition. The var. *alabamensis* occurs in an open, glade habitat in shallow, gravelly soil, where it often grows in low clumps. It generally has a compact, leathery habit with short internodes and ascending leaves with the leaf margins curling upwards. In contrast, var. *gentianoides* is usually found under the shade of a pine/mixed hardwood canopy or pine monoculture in humous- or duff-covered soil. In this environment it generally has one thin, weak stem with elongate internodes and thin, outspread leaves. However, the var. *gentianoides* takes on the former habit when grown in full sun and sandy soil, as it does at Bok Tower Gardens' Endangered Plant Program in Lake Wales, Florida.

Populations of *Spigelia gentianoides* var. *alabamensis* are much larger in extent and number of individuals than the present-day populations of var. *gentianoides*, with some glades containing thousands of individuals. However, the new variety appears to be entirely localized to these rare glade communities, and should therefore be considered a rare plant in need of protection.

ACKNOWLEDGMENTS

I am grateful to James Allison for calling the new *Spigelia* populations to my attention and providing feedback on this description, James Affolter for his personal observations and helpful comments, Angus Gholson for his field assistance in Florida, Steven Ginzburg for providing plant material, Tammera Race for access to the Endangered Plant garden at Bok Tower Gardens and providing plant material, Billie L. Turner for academic advising and editing, Gayle Turner for the Latin diagnosis, and an anonymous reviewer for comments on the manuscript.

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BOOK NOTICE

ANDREWS, JEAN. 1995. **PEPPERS. The Domesticated Capsicums New Edition.** (ISBN 0-292-70467-4, hbk.) University of Texas Press, P.O. Box 7819, Austin, Texas 78713-7819, (512) 471-4032, \$65, 274 pp, 34 full page color plates, 24 color photos, 20 b&w illustrations, 3 maps, 11 tables.

Originally published in 1984, *PEPPERS* has become a chili icon—the classic and complete source for the history, biology, taxonomy, cultivation, medicinal and culinary uses of the domesticated *Capsicum*. This new addition has updates in each section.

Artist and author, Andrews takes unique and creative license of style by leaving the foliage nearly devoid of color in each illustration which places more emphasis on the actual peppers. This makes the 34 full color plates not just botanical illustrations, but selective windows to the individuality of each *Capsicum*. Flaws on stem and fruit, the odd chewed leaf here and there brings the illustrations a naturalness juxtaposed to the unreal aspect of colorless leaves. You can almost feel the skin of the jalapeño with the characteristic cracking of its flesh as it ages on the stems.

Dr. Andrews received her Ph.D. in art from the University of North Texas and it has stead her well in this, once again, even more, researched new addition. So beautifully illustrated, it's worth looking at again and again.—*Linny Heagy*.

THE CURRENT STATUS OF *CYPRIPEDIUM*
KENTUCKIENSE (ORCHIDACEAE)
INCLUDING A MORPHOLOGICAL ANALYSIS
OF A NEWLY DISCOVERED POPULATION
IN EASTERN VIRGINIA

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ABSTRACT

In 1995, a population of 120 very large yellow lady's slippers was discovered in a remote ravine on the Northern Neck peninsula of Eastern Virginia. Multivariate and univariate analyses of morphological variation in the Virginia population suggest that these individuals belong to a rare species, *Cypripedium kentuckiense*, and not the more common yellow lady's slipper, *C. parviflorum* var. *pubescens*. These analyses also indicate that the dorsal sepal width and orifice length are two important characters that can be used to discriminate between *C. kentuckiense* and *C. parviflorum* var. *pubescens*. A few individuals at the Virginia site approached the size of *C. parviflorum* var. *pubescens* in some characters which may be due to historical introgressive patterns or genetic isolation. Lastly, a survey of records on *C. kentuckiense* populations revealed that Arkansas contains the largest number of populations (70 out of 156). These records also indicate that *C. kentuckiense* is characterized by a majority of populations (58%) with less than 21 individuals.

RESUMEN

En 1995 se descubrió una población de 120 individuos de zapato de venus ("yellow lady's slippers" en inglés) en un barranco alejado localizado en la península llamada "Northern Neck" del este del estado de Virginia, EEUU. Un análisis multivariante y univariante de la variación morfológica en la población investigada de Virginia sugiere que estos especímenes pertenecen a una especie rara, *Cypripedium kentuckiense*, en vez de la especie más común de zapato de venus *C. parviflorum* var. *pubescens*. Este análisis también indica que la anchura del sépalo dorsal y la longitud del orificio son dos características importantes que pueden ser usadas para distinguir *C. kentuckiense* de *C. parviflorum* var. *pubescens*. Unos especímenes del lugar de investigación en Virginia se aproximan al tamaño de *C. parviflorum* var. *pubescens* en algunas características que pueden explicarse debido a patrones históricos introgresivos o aislamiento genético. Por último, una revisión del conjunto de investigaciones sobre poblaciones de *C. kentuckiense* reveló que el estado de Arkansas contiene el número más grande de poblaciones (70 de 156). Estas investigaciones también indican que *C. kentuckiense* está caracterizado por una mayoría de poblaciones (58%) con menos de 21 especímenes.

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INTRODUCTION

The *Cypripedium calceolus* L. complex in North America is currently thought to comprise four species and three varieties (Sheviak 1992, 1994). It includes the yellow lady's slipper taxa [*C. parviflorum* var. *parviflorum* Salisb., *C. parviflorum* var. *pubescens* (Willd.) Knight, and *C. parviflorum* var. *makasin* (Farw.) Sheviak] as well as lady's slipper taxa that contain white and creamy white labella (*C. montanum* Douglas ex Lindley, *C. candidum* Muhlenb. ex Willd., and *C. kentuckiense* C. Reed). *Cypripedium parviflorum* occupies the largest range of all species in the North American group, occurring in approximately 40 states and throughout most of Canada (Luer 1975). In addition to its large range, *C. parviflorum* displays high levels of morphological variation which has led to the delimitation of many specific and subspecific taxa (see review in Newhouse 1976). The delimitation of taxa within *C. parviflorum* is complicated by complex hybridization patterns among its varieties and related species (e.g., Klier et al. 1991; Case 1993), regional variation in reproductive isolating mechanisms (Case 1993), and very high levels of genetic variation (Case 1994). The extensive morphological variation and complex breeding patterns of *C. parviflorum* and related taxa have caused them to be the subject of many taxonomic and evolutionary debates that have persisted for more than 200 years.

One of the most recently described species in the N. American group is the relatively rare *C. kentuckiense*. This species most closely resembles *C. parviflorum* var. *pubescens* in morphology and appears to be a taxon that was recently derived from *C. parviflorum* var. *pubescens* (Case 1994). Although *C. kentuckiense* was not validly described until 1981, its morphological concept may date back to an entity described by Rafinesque in 1828, named *C. luteum* var. *grandiflorum* Raf. However, the lack of a type specimen designation for the Rafinesque name precludes a definitive association between this name and a biological entity (Atwood 1984). Prior to its valid description by Reed, *C. kentuckiense* was considered part of one polymorphic North American lady's slipper species (e.g., Correll 1950) or considered to be a distinct species [Soukup (1977) invalidly described this species under the name *C. daultonii*].

Shortly after its valid description, Atwood (1985) conducted a study to clarify the range of *C. kentuckiense* by examining herbarium and live specimens from the southeastern United States. He concluded that Arkansas had the largest number of localities (11), but suggested that this might be an artifact due to less collection effort in some states [e.g., Mississippi (1) and Alabama (1)]. He also found locations for *C. kentuckiense* in Oklahoma (4), Texas (2), Louisiana (5), Tennessee (1), and Kentucky (4), but did not find this taxon represented in the Carolinas or Virginia. He suggested that

conservationists be on the lookout for this taxon in Missouri, Illinois, Indiana, Ohio, West Virginia, and Georgia. Since then, there have been numerous attempts to find *C. kentuckiense* in these bordering states, but there are no documented records of any discoveries to date (Larry Morse pers. comm.). Currently, the global rank of *C. kentuckiense* indicates that it is threatened throughout its range (G3), while the federal ranking (C2) indicates that it is a likely candidate for the list of federal endangered and threatened species. However, its C2 rank also implies that it will be necessary to obtain further biological information pertaining to potential threats to the species to determine whether or not it should be placed on the federal list (Department of the Interior 1993). At the state level, *C. kentuckiense* is most often given S1 status (i.e., critically imperiled, extremely rare, and very vulnerable to extirpation; Table 1).

In 1995, a population of *C. kentuckiense* was discovered (Weldy 1995) on the Northern Neck peninsula of eastern Virginia (between the Rappahannock and Potomac rivers), approximately 285 mi from the nearest known *C. kentuckiense* locality in northeastern Kentucky. The population contains approximately 120 individuals and is located along a sandy ravine bottom adjacent to a small stream (hereafter the population is called the Virginia population). The most notable aspects of the Virginia population are the large overall size of the individuals and their creamy yellow labella (Fig. 1). The latter characteristic is far more typical of *C. kentuckiense* than *C. parviflorum* var. *pubescens*, which usually has bright yellow labella. Although this population strongly resembles *C. kentuckiense*, some individuals approach the size of *C. parviflorum* var. *pubescens*, which is a smaller taxon. Therefore, the first objective of this paper is to quantify the morphological variation within the Virginia population of *C. kentuckiense* in relation to other *C. kentuckiense* and *C. parviflorum* var. *pubescens* populations. Our second objective is to review the number of populations, population sizes, and locations of all *C. kentuckiense* populations. This review is intended to provide a phytogeographical perspective for the Virginia population and provide an updated review of the national status of *C. kentuckiense*.

MATERIALS AND METHODS

To obtain information on the current status of *Cypripedium kentuckiense* populations, element occurrence records were examined from Natural Heritage offices in states with known localities. These states included Alabama, Arkansas, Kentucky, Louisiana, Mississippi, Oklahoma, Tennessee, and Texas. In addition, Heritage offices in states adjacent to those containing *C. kentuckiense* populations were contacted for data on *C. kentuckiense* sites. These included Georgia, Illinois, Indiana, Missouri, North Carolina, Ohio, South Carolina, Virginia, and West Virginia. For each state, records were



FIG. 1. *Cypripedium kentuckiense* in Virginia. Photograph by T. Weldy.

obtained on the number of known populations and the number of individuals in each population. When state records included a range for any given population size, the maximum population size was used in our review. If information from more than one survey was indicated for any given population, the most recent record that reported the number of individuals in the population was used. It should be noted, however, that in some cases the most recent record was an original record that was unverified by Heritage botanists. Therefore, the number of populations reported in this study may be an overestimate due to the inclusion of records that have not recently been verified. Populations for which no data were given on the number of individuals present were included in the total count of populations but were not included in any other statistics. Thirty-five percent of all populations reported did not contain census data on the number of individuals present. Therefore, the numbers of individuals per state given in Table 1 are likely to be underestimates of the actual number per state.

To establish the taxonomic identity of the Virginia population, multivariate and univariate analyses of 13 morphological characters were conducted. Nine of these characters were used by Reed (1981) in his diagnosis of *C. kentuckiense*. The specimens used in this analysis included 14 individuals from the Virginia population of *C. kentuckiense*, 5 individuals from 5 *C. kentuckiense* populations in Texas and Arkansas, and 35 individuals from 13 populations of *C. parviflorum* var. *pubescens* from Michigan, Missouri, Georgia, Indiana, and Virginia. For each specimen, the following morphological characters were measured: plant height (to the top of the ovary), staminode length, length and width of the longest leaf, length and width of the petals, length and width of the dorsal sepal, length and width of the labellum, length and width of the labellum orifice, and the number of 180° turns in the lateral petals. Those characters in this analysis that were not used by Reed (1981) include the orifice dimensions, staminode length, and the number of 180° turns in the lateral petals. In addition, we noted labellum color in the field but did not include it in the quantitative analyses. All measurements were made on living specimens in natural populations by L. E. Wallace, M. A. Case, or H. T. Mlodozieniec.

Multivariate analysis of morphological characters consisted of a principal components analysis (PCA) using NTSYS (Rohlf 1988) to evaluate the existence of natural groupings among all 54 specimens. A variance/covariance matrix was calculated from standardized measurements (i.e., these measurements were in units of standard deviation from the mean) and the first two principal axes were extracted. The axis coordinates for all the individuals were subsequently plotted. For univariate statistical analyses, the existence of unequal sample variances, non-normal sample distributions, and a relatively small sample size of the western *C. kentuckiense* group prohibited the use of parametric tests. Therefore, a Kruskal-Wallis non-parametric mean rank test (Sokal & Rohlf 1995) was applied to test for character differences among the three groups. These groups were defined as the Virginia population, the western *C. kentuckiense* individuals, and all *C. parviflorum* var. *pubescens* individuals. Subsequently, a Dunn's non-parametric multiple comparisons test was used to test all pairwise comparisons among the groups (Zar 1996). The latter was applied to those characters that displayed overall significant differences among groups in the Kruskal-Wallis test. Arithmetic means, standard errors, and ranges of the characters were also calculated using EXCEL (Microsoft 1993).

RESULTS

The survey of element occurrence records revealed that there are 156 populations of *Cypripedium kentuckiense* known. Arkansas had the largest number of populations as well as 66.4% of all reported individuals (Table 1). Ken-

tucky had the second largest number of populations (36) and Louisiana had the third largest number (19). However, the mean population size in Louisiana (6) is very small compared to the mean population sizes reported in other states (17–117). Therefore, Louisiana contains only 1.5% of all reported individuals. Only 9 populations of *C. kentuckiense* are known from Tennessee, but this state contains 13.4% of all reported individuals. This is due to the relatively large population sizes found in Tennessee. Lastly, the majority (58%) of population sizes reported from all states ranged between 1–20 individuals (Fig. 2). Furthermore, 43% of all populations had only 1–10 individuals.

The PCA revealed two distinct groupings on axis 1 which separates *C. parviflorum* var. *pubescens* from *C. kentuckiense* individuals (Fig. 3). The first axis explained 72% of the variation whereas the first two axes combined explained 81% of the variation. With the exception of the degree of petal turns which had a low negative correlation with the first axis (-0.11), all remaining characters had strong positive correlations with the first axis. These values ranged from 0.70 for leaf length to 0.96 for dorsal sepal width. The remaining characters all had correlation values greater than 0.81.

Results of the univariate statistical tests parallel the multivariate results. With the exception of the degree of petal turns which was not significantly different among groups ($p > 0.05$), highly significant differences ($p < 0.001$; Kruskal-Wallis test) were found among groups for all other characters. In pairwise group comparisons for these twelve significant characters (Dunn's non-parametric multiple comparisons test), *C. kentuckiense* from Arkansas and Texas were never significantly different from *C. kentuckiense* from Virginia. In contrast, each of these two *C. kentuckiense* groups were highly significantly different from the *C. parviflorum* var. *pubescens* group (Table 2). In general, the upward range limits of character measurements for *C. parviflorum* var. *pubescens* overlap slightly with the lower range limits of characters recorded for the two *C. kentuckiense* groups. For a few characters (e.g., dorsal sepal width and orifice length) the measurement ranges of *C. parviflorum* var. *pubescens* relative to the *C. kentuckiense* groups were well separated and non-overlapping. These multivariate and univariate statistical results reflect the large size of most *C. kentuckiense* individuals relative to *C. parviflorum* var. *pubescens* individuals.

DISCUSSION

The morphological evidence presented in this paper indicates that the Virginia population is best interpreted as a disjunct population of *C. kentuckiense*, and not as a new taxon or population of large *C. parviflorum* var. *pubescens*. Our multivariate and univariate data analyses are consistent with the hypothesis of two morphological groups. In all group comparisons where

TABLE 1. Distribution and density statistics for *Cypripedium kentuckiense* populations throughout its known range. The information provided includes: the state where populations are located (first column); the state occurrence rank for *C. kentuckiense* [second column (S1 = critically imperiled in state, extremely rare, and very vulnerable to extirpation; SU = possibly in peril in state, but status uncertain; S3 = rare or uncommon in state)]; the month and year the data were obtained (third column); the total number of known populations per state and percent of all populations found within each state (fourth column); the total number of reported individuals per state and percent of all individuals found within each state (fifth column); and the mean±standard deviation, and range of population sizes calculated from occurrence records (sixth column). Sixty five percent of all occurrence records included census data on the number of individuals per population. Summary statistics are in the totals row.

State	Rank	Date	# Pops. & (% of Total)	# Individuals & (% of Total)	Mean±sd & (Range of Pop. Sizes)
AK	S3	4/95	70 (44.9)	2,884 (66.4)	60±94 (1–450)
KY	S3	10/95	36 (23.1)	380 (8.8)	17±22 (1–100)
LA	S1	10/95	19 (12.2)	67 (1.5)	6±5 (1–15)
TN	S1	10/95	9 (5.7)	584 (13.4)	117±108 (14–300)
TX	S1	3/95	8 (5.1)	110 (2.5)	18±15 (3–42)
OK	S1	3/95	7 (4.5)	148 (3.4)	21±25 (3–60)
AL	S1	10/95	4 (2.6)	—	—
MS	SU	3/95	2 (1.3)	50 (1.2)	—
VA	—	—	1 (0.6)	120 (2.8)	—
Totals or Mean	—	—	156 (100)	4,343 (100)	42±75 (1–450)

overall significant differences exist, no significant differences were found between the *C. kentuckiense* and Virginia population comparisons whereas *C. kentuckiense* and the Virginia population were always significantly different from *C. parviflorum* var. *pubescens* (Table 2). Furthermore, the dimensions of characters measured for each taxon are generally within the ranges previously reported (Table 2). However, the dimensions of eight characters measured for *C. kentuckiense* individuals fell outside the ranges previously published for this taxon in Reed (1981) or Gleason and Cronquist (1991). These characters and their corresponding maximum or minimum values were height (53 cm; Virginia population), leaf width (14 cm; Virginia population), petal length (14 cm; Virginia population), petal width (1.0 cm; Virginia and western *C. kentuckiense*), dorsal sepal length (10.5 cm; western *C. kentuckiense*), dorsal sepal width (5 cm; Virginia population), labellum length (6.3 cm; western *C. kentuckiense*), and labellum width (4.5 cm; Virginia population). It is important to note that these values substantially increase the previously published ranges for these characters and that the Virginia population as well as the more western *C. kentuckiense* populations contributed to these increases in character ranges. A substantial increase in

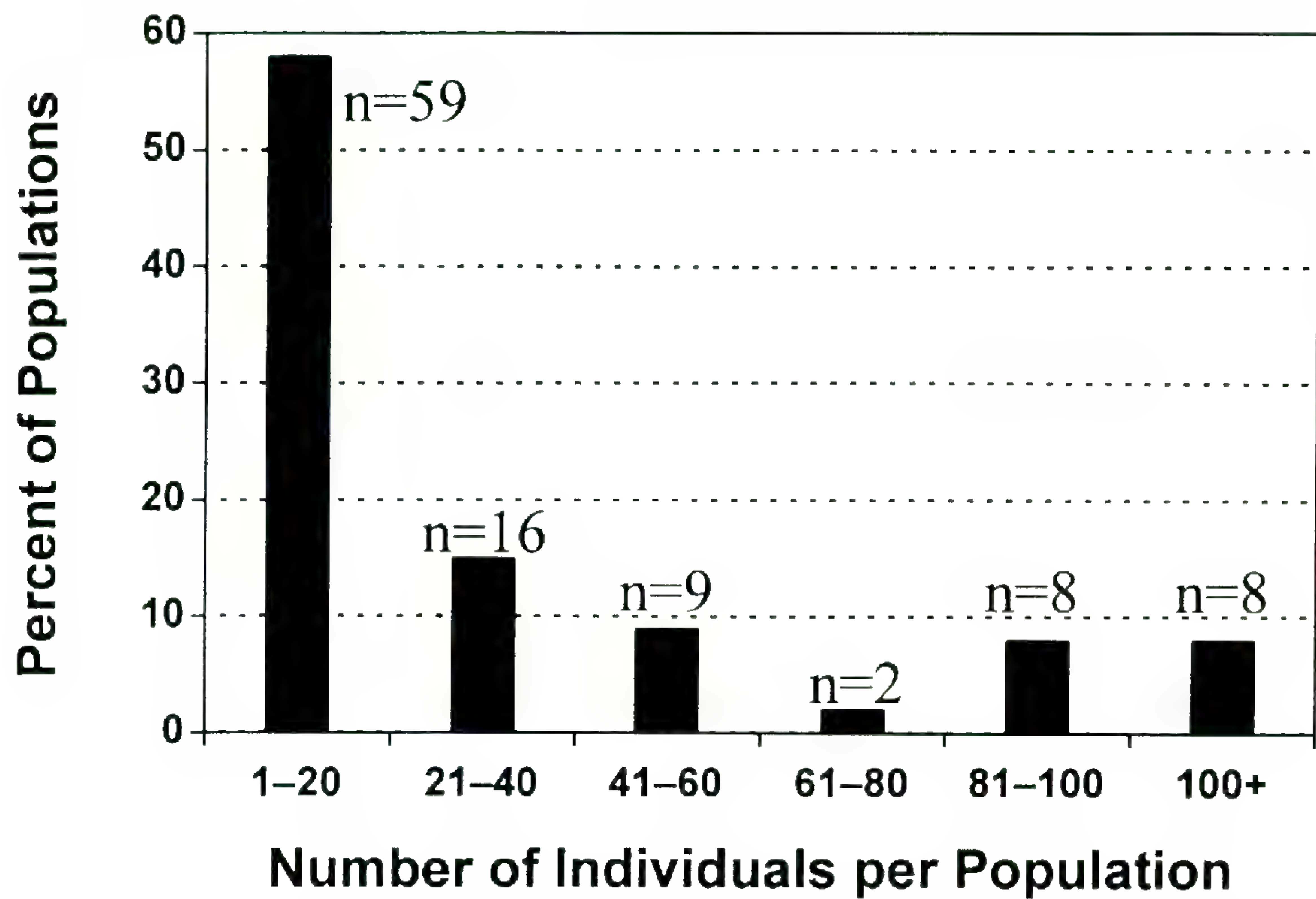


FIG. 2. Distribution of population sizes for 102 (65%) *Cypripedium kentuckiense* population records reporting sizes.

the ranges of characters for *C. kentuckiense* was also found by Sheviak in his treatment of *Cypripedium* for Flora North America (Sheviak pers. comm.; Table 2). The results of the present study and Sheviak's results indicate that prior sampling of *C. kentuckiense* has not been sufficient to determine the morphological ranges of these characters. Therefore, we recommend that floristic researchers be aware of the changing concept of character variation in this taxon. Moreover, our analysis indicates that dorsal sepal width and orifice length may be the most important characters for discriminating between *C. kentuckiense* and *C. parviflorum* var. *pubescens*. These were the only two characters in our study that did not overlap between these two species (Table 2).

Qualitative floral traits of the Virginia population are also consistent with traits found in more western sites. First, the Virginia population is composed of individuals with creamy yellow labella, dark maroon petals and sepals, and dorsal sepals with prominent green and maroon striations near the sepal base (Fig. 1). These characteristics were always present in the five *C. kentuckiense* populations visited in Texas and Arkansas, but they were absent or rare in the *C. parviflorum* var. *pubescens* populations visited (Mlodozieniec pers. obs.). Furthermore, the habitat of the Virginia population (i.e., sandy substrate in the flood plains of creeks) is consistent with

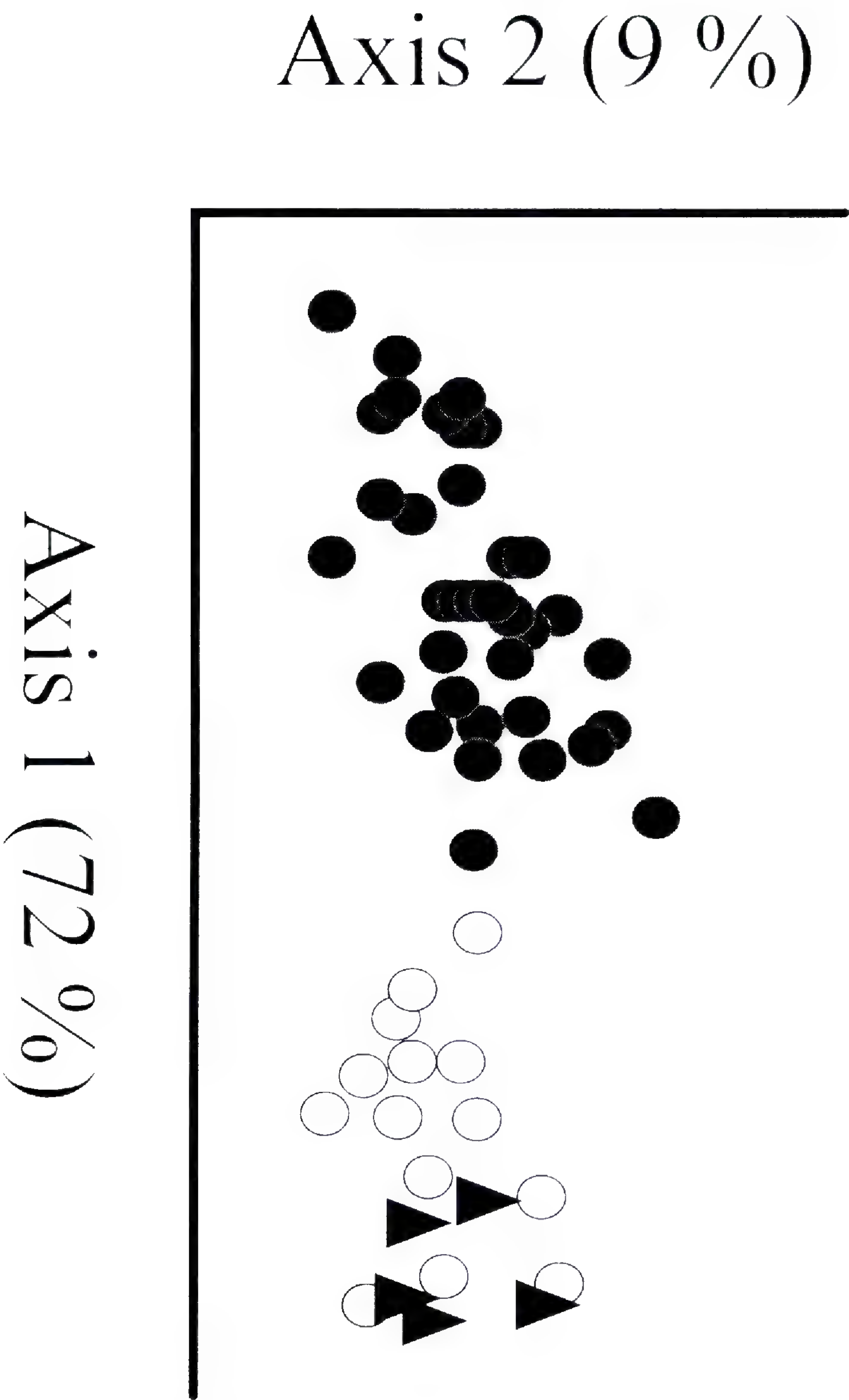


FIG. 3. Principal components analysis of 35 *Cypripedium parviflorum* var. *pubescens* individuals (black circles), 5 *C. kentuckiense* individuals from Arkansas and Texas (black triangles), and 14 *C. kentuckiense* from Virginia (white circles). The amount of variation explained by axis 1 and axis 2 is given in parentheses. The morphological characters used in this analysis are given in Table 2.

TABLE 2. Arithmetic mean±standard errors and ranges (in parentheses) of morphological characters obtained from 54 living specimens, and combined ranges of characters reported by Gleason and Cronquist (1991)¹, Sheviak (pers. comm.)², and/or Reed (1981)³. Measurements are in cm. Statistical groups include *Cypripedium parviflorum* var. *pubescens* from all populations (PUB), *C. kentuckiense* from Texas and Arkansas (KENT), and the Virginia population of *C. kentuckiense* (VA). Different superscript letters among groups within a morphological character indicate significant differences in mean rank scores among pairwise group comparisons at $p < 0.005$ (*) or $p < 0.001$ (**) levels (Dunn's non-parametric multiple comparison test for Kruskal-Wallis mean rank test).

Character & ranges of measurements previously reported	Measurements from this study (individuals measured indicated by n)		
	PUB (n=35)	KENT (n=5)	VA (n=14)
Height PUB (20–80) ¹ ; KENT (35–97) ²	^{a**} 45.7±1.5 (27.8–60.5)	^b 67.0±1.6 (63.0–70.0)	^b 60.8±1.5 (53.0–68.0)
Leaf length PUB (6–20) ¹ ; KENT (13–24) ²	^{a*} 14.6±0.4 (9.0–21.0)	^b 19.5±0.4 (18.0–20.0)	^b 17.6±0.5 (15.0–20.0)
Leaf width KENT; (4.3–15) ²	^{a**} 6.9±0.4 (2.8–10.5)	^b 11.5±0.4 (10.5–13.0)	^b 10.6±0.5 (8.0–14.0)
Staminode length	^{a**} 1.2±0.03 (0.8–1.7)	^b 1.9±0.2 (1.5–2.5)	^b 1.6±0.06 (1.5–2.0)
Petal length PUB (5–8) ¹ ; KENT (8–15.6) ^{1,2}	^{a**} 7.0±0.3 (4.4–10.5)	^b 11.5±0.3 (10.5–12.5)	^b 11.4±0.3 (9.5–14.0)
Petal width KENT (0.7–1.5) ²	^{a*} 0.7±0.03 (0.5–1.0)	^b 1.0±0	^b 1.0±0
Dorsal sepal length PUB (3–8) ¹ ; KENT (6.1–12.6) ²	^{a**} 5.5±0.2 (3.5–7.5)	^b 9.4±0.3 (9.0–10.5)	^b 8.8±0.2 (7.5–10.0)
Dorsal sepal width KENT (2.4–6.5) ²	^{a**} 2.2±0.06 (1.5–2.9)	^b 4.5±0 –	^b 4.1±0.1 (3.5–5.0)
Labellum length PUB (3–5) ¹ ; KENT (4.1–6.5) ²	^{a**} 3.8±0.1 (2.5–5.8)	^b 5.9±0.2 (5.5–6.3)	^b 5.5±0.1 (4.5–6.0)
Labellum width KENT (3.5) ³	^{a**} 2.2±0.05 (1.5–3.0)	^b 3.9±0.06 (3.7–4.0)	^b 3.5±0.1 (3.0–4.5)
Orifice length KENT (2.7–3.7) ²	^{a**} 0.9±0.03 (0.5–1.3)	^b 3.9±0.06 (3.7–4.0)	^b 3.5±0.1 (3.0–4.5)
Orifice width	^{a**} 1.0±0.04 (0.5–1.5)	^b 2.2±0.2 (1.5–2.5)	^b 1.8±0.08 (1.4–2.5)
Number of 180° turns in petals	^a 3.7±0.2 (1–7)	^a 3.2±0.5 (2–5)	^a 2.7±0.4 (0–5)

the habitat that is typically reported for *C. kentuckiense* in the eastern portion of its range (Whitlow 1986).

Even though no significant differences exist in the morphological characters measured among the Virginia site and the more western sites, the range of character measurements were generally much larger in the Virginia population than in the more western sites (Table 2). This, in part,

could be due to a relatively small sample size of the western *C. kentuckiense*. Alternatively, the Virginia population may be composed of individuals that differ slightly from populations in the remainder of the species' range. A long period of genetic isolation or introgression with *C. parviflorum* var. *pubescens* might have contributed to this pattern. Although non-overlapping groups were formed by the PCA, one Virginia *C. kentuckiense* individual clustered very close to an individual of *C. parviflorum* var. *pubescens* (Fig. 3). This *pubescens* individual was from a population that was 95 mi from the *C. kentuckiense* site. The similar PCA clustering region of these two individuals might indicate historical patterns of introgression. However, Weldy (1995) did not find *C. parviflorum* var. *pubescens* at the Virginia site or in adjacent ravines. In addition, high levels of year-to-year morphological variation within the same individual of *C. kentuckiense* have been observed by Sheviak (pers. comm.). Similar non-genetic contributions to phenotype might also explain why some individuals of *C. kentuckiense* approach the dimensions of *C. parviflorum* var. *pubescens*. Research is currently in progress to address hypotheses concerning the population genetic characteristics of *C. kentuckiense* and *C. parviflorum* var. *pubescens* in Virginia.

It is interesting to note that the Virginia population contains approximately 120 individuals. This large population size is relatively uncommon for this species (Fig. 2) and might be considered especially unusual for a population at the fringe of its species' range. Most documented *C. kentuckiense* populations contain fewer than 21 individuals. Although small population sizes can be caused by many contributing factors (e.g., Harper 1987), we hypothesize that small *C. kentuckiense* population sizes are, in part, due to low rates of population growth. Life history characteristics that could contribute to low rates of population growth include a low rate of seed germination, high seed-to-adult mortality, and a long development time from seed to flowering adult. Furthermore, high seed dispersal rates are expected in *C. kentuckiense* due to its highly reduced wind-dispersed seeds. This combination of characteristics could account for the observed pattern of widely-dispersed, small, isolated populations. Lastly, slow population growth rates appear to occur in related species such as *C. parviflorum* var. *pubescens*. In this taxon, estimates indicate that a seed can require up to 16 years of growth before flowering (Curtis 1954). In other *Cypripedium* taxa such as *C. acaule* Aiton, pollinator limitation may be an important factor in causing low levels of seed set (Davis 1986; Helenurm & Barret 1987; Gill 1989). Pollinator limitation may also play a role at the Virginia site. Out of 120 individuals examined in 1996, no capsules were present from the previous year and floral visitation during 1996 was very low (Case & DeWitt pers. obs.).

Although a number of *C. kentuckiense* sites have been found since 1985, it is our opinion that this taxon should remain a potential candidate for the

federal endangered and threatened species list (i.e., category 2 or, with more documentation of threats to existing populations, elevation to category 1). Only 156 populations are known with the majority (68%) of the populations occurring in only two states, Arkansas and Kentucky. In some states, such as Louisiana, this species seems to be particularly at risk. Approximately 10 Louisiana populations (not included in this study) have been extirpated primarily due to logging and development (Julia Lark pers. comm.). The remaining states listed in Table 1 each contain less than 6% of all populations each. The infrequent and scattered occurrences of *C. kentuckiense* in states ranging from Virginia to Texas may be the remnants of more widely distributed and abundant ancestral populations. In this case, it will be particularly important to categorize the demographic, genetic, and anthropogenic threats to the extant populations, especially in light of the large number of small, apparently isolated populations. Potential future discoveries of populations in new regions, such as the mountains bordering Virginia and West Virginia might be expected. These discoveries could provide important new insights into the distribution and genetic structure of this rare orchid.

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BOOK NOTICE

FAUTIN, DAPHNE GAIL, DOUGLAS J. FUTUYMA, and FRANCES C. JAMES, eds.
1995. **Annual Review of Ecology and Systematics. Volume 26.**
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The first eleven chapters of Volume 26 are devoted to a special section on Sustainability Issues. From the Preface: "Several chapters were written by authors invited to discuss sustainability from the perspectives of disciplines not typically included in *ARES*. Topics and authors for the section were selected in part to demonstrate some of the ways in which this word is employed—a diversity that extends to the underlying assumptions and principles used in discussions of and proposals for sustainability. This section will have achieved one of its aims if readers come away recognizing some of these differences and the need to be explicit in their own usage and about the underpinnings of their positions." The remaining 19 chapters cover various aspects of ecology and systematics. Examples include Women in Systematics, Molecular evidence for Natural Selection, The Role of Nitrogen in the Response of Forest Net Primary Production to Elevated Atmospheric Carbon Dioxide, Architectural Effects and the Interpretation of Patterns of Fruit and Seed Development, and Plant-Vertebrate Seed Dispersal Systems in the Mediterranean: Ecological, Evolutionary, and Historical Determinants. Indexes include: Subject; Cumulative Index of Contributing Authors, Volumes 22–26; and Cumulative Index of Chapter Titles, Volumes 22–26.

CONDUCTIVE TISSUE IN *CERATOPHYLLUM* *DEMERSUM* (CERATOPHYLLACEAE)

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ABSTRACT

Using scanning electron microscopy (SEM) and light microscopy, we attempted to establish if xylem and phloem occur in *Ceratophyllum* stems; roots are lacking in the genus. In larger stems, a central core of elongate cells contains scattered sieve tube elements with simple sieve plates; the sieve tubes are associated with companion cells. Sieve tubes are not organized into phloem strands. The central core of main and branch stems contains elongate cells, some of which lack starch and tannins. These cells lack any evidence of the annular or helical thickenings of secondary wall material characteristic of primary xylem in other vascular plants, and therefore xylem cannot be claimed for *Ceratophyllum*. Absence of xylem in *Ceratophyllum* is interpreted as secondary, a loss related to adaptation to the submersed habit.

RESUMEN

Empleando la microscopía electrónica de barrido y la microscopía óptica, hemos intentado establecer si existe xilema y floema en los tallos de *Ceratophyllum*; no existen raíces en el género. En los tallos más grandes, un núcleo central de células alargadas contiene elementos cribosos dispersos; estos elementos cribosos tienen placas cribosas simples y están asociados con células compañeras. Los elementos cribosos no se organizan en paquetes de floema. El núcleo central de los tallos principales y laterales contiene células alargadas, y en algunas falta el almidón y los taninos. Estas células no tienen engrosamientos espiralados o anillados en la pared secundaria característicos del xilema primario en otras plantas vasculares, y no puede decirse que haya xilema en *Ceratophyllum*. La ausencia de xilema en *Ceratophyllum* se interpreta como secundaria, una pérdida relacionada con la adaptación al hábito sumergido.

INTRODUCTION

Ceratophyllaceae have recently attracted attention because of shifts in concepts of their evolutionary relationships. Earlier phylogenetic schemes placed them nearer such families of aquatic dicotyledons as Cabombaceae (Ito 1987) or Nelumbonaceae (Thorne 1987); Les (1988) reviewed placements by various authors. Cladistic analyses based on macromorphological data have placed Ceratophyllaceae near Nymphaeaceae, in a basal position in dicotyledons (Les 1988). Cladistic analysis of *rbcL* data (Les et al. 1993; Qiu et al. 1993) confirmed this idea, and locates Ceratophyllaceae as the outgroup of all other angiosperms. Conceding that Ceratophyllaceae may

contain both specialized and primitive features, knowledge of any feature in the family is important in view of the phyletic placement now accorded Ceratophyllaceae.

Klercker (1885) showed that *Ceratophyllum* has sieve-tube elements with associated companion cells ("cellules adjunctives"), but reported no xylem cells. Jones (1931) found sieve-tube elements and companion cells; he claimed presence of phloem parenchyma, and also believed that "some of the sieve tubes show evidence of transformation into air spaces. This degeneration is particularly evident in stems in which the aerenchyma is strongly developed." Jones further claimed that "the xylem is so degenerated that there is in reality very slight evidence of this tissue. There are two kinds of cells composing the xylem. One is larger than the other in diameter and has thicker walls. It is probably a reduced vessel. The other is of the xylem parenchyma type. There is abundant evidence that the reduced vessel-like cells are becoming parenchymatous." Jones cited presence of tannins, chloroplasts, and starch in the "reduced vessel-like" cells surrounding the central canal. In his legend for a transection of a mature stem, Jones's conclusions are somewhat ambiguous. He believed that there is "transformation of some xylem vessels into parenchyma cells," but also considers that "it is perhaps more appropriate to designate all the tissue inside the phloem as pith since the cells appear to be assuming the function of parenchyma and in a few cases, even that of chlorenchyma. Furthermore they are quite similar to parenchyma cells in appearance." Jones (1931) failed to find any evidence of lignin in cells.

The purpose of our study is to reinvestigate the nature of conductive tissue in *Ceratophyllum*, using both light microscopy and SEM. Is the phloem clearly referable to that concept, as Jones claimed? Does the central tissue of stems (either main or branch stems) deserve the designation of xylem, or is it merely pith? Is there any evidence that cells are "reduced" vessels or tracheids? Is reduction or absence of xylem related to adaptation to the aquatic habitat, as Jones (1931) claimed?

MATERIALS AND METHODS

Our materials of *Ceratophyllum demersum* L. were collected from two sites, both in Texas, during September, 1995. The primary collection site was Aquarena Springs, the headwaters of the San Marcos River in San Marcos, Texas. In this site, where clear water of constant temperature ($21^{\circ} + 1^{\circ}\text{C}$) emerges from a limestone aquifer, *C. demersum* is common, with several individuals anchored at depths of more than 5 m. Additional collections were obtained from Toledo Bend Reservoir, Sabine County in eastern Texas.

Stems were fixed in 50% ethanol. Portions were dehydrated according

to the tertiary butyl alcohol method (Johansen 1940), embedded in paraffin, and sectioned on a rotary microtome. Some sections were stained with a safranin-fast green series corresponding to Northen's modification of Foster's tannin acid-ferric chloride method (Johansen 1940). Other sections were mounted on aluminum stubs much as paraffin sections would be affixed to glass slides; these sections were then cleansed of paraffin with xylene, sputter coated, and then observed with a Bausch and Lomb Nanolab SEM.

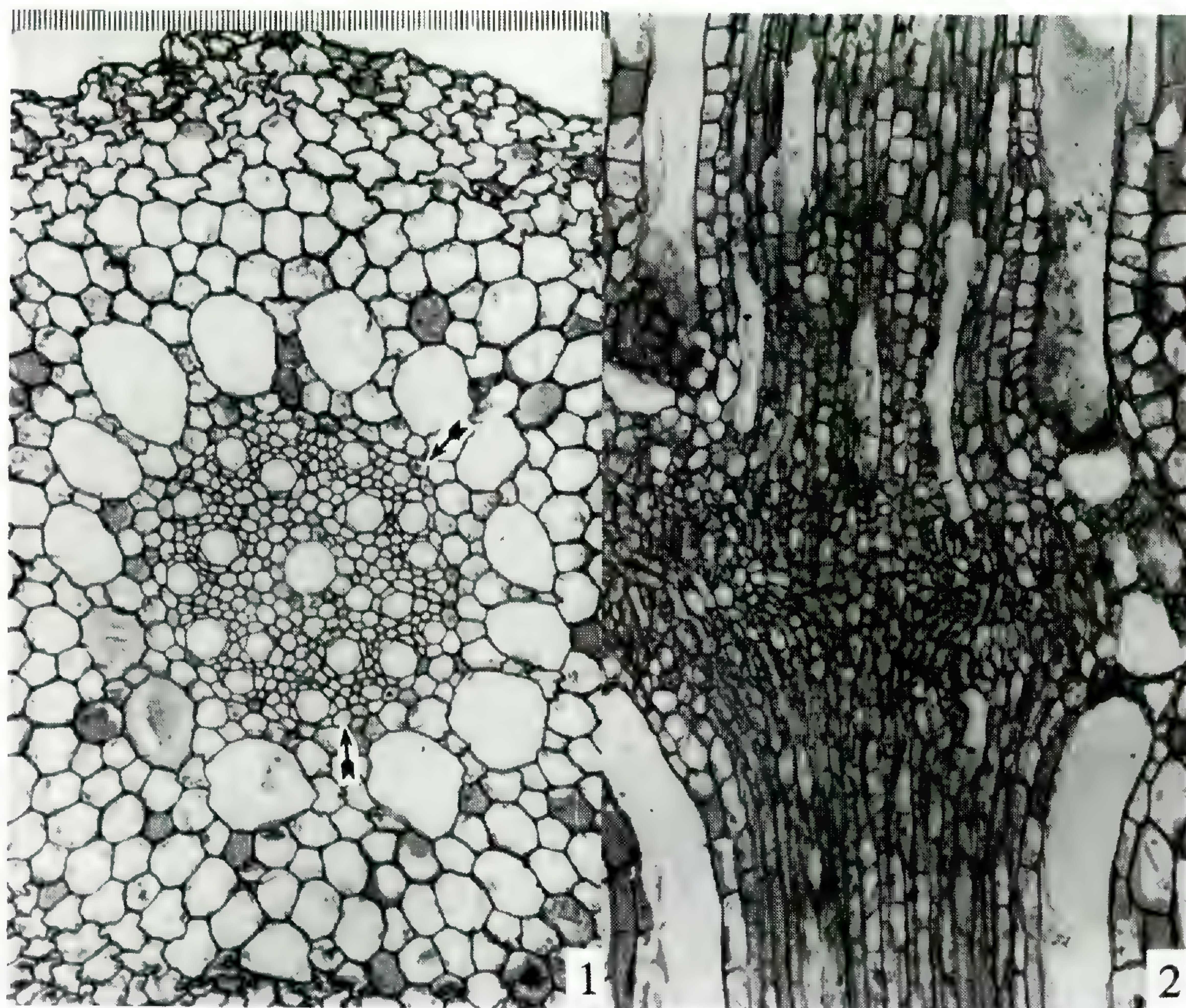
ANATOMICAL RESULTS

Transections of the main stem (Fig. 1) have a cortical region delimited by a circle of rather large cylindrical air canals, appreciably larger than the parenchyma cells of the cortex. Internal to the cylinder of air canals is what Jones (1931) considered the vascular core. Although we did not find any histological differentiation of the cells at the periphery of the core, Jones (1931) identified an endodermis in labels of his figures. Presumably he considered the narrowest cells at the periphery of the vascular core to be endodermis (Fig. 1). Within the vascular core, there are air canals (Fig. 1, center). Longisections show that these are air canals rather than enlarged cells. One of these may be placed centrally in the core (Fig. 1). This designation is in agreement with Jones (1931), who, however, thought of these stelar air canals as modified sieve tubes: "the erstwhile sieve tubes are being modified for this purpose." In general, the sieve-tube elements are located in the outer portion of the vascular core, as one might expect in a dicotyledonous stem.

If one views a longisection of a *Ceratophyllum* stem, one sees that at nodal regions, cells of the central core are irregular in orientation, and the vertical air spaces are interrupted by a nodal plate (Fig. 2). The nodal region as seen in transection (Fig. 3) illustrates that strands of elongate cells extend from the vascular core into the branches that occur in verticillate fashion at the nodes.

Examining with SEM the cells that lead from the central core into the branches, one finds that most of these cells are elongate, or prosenchymatous, in shape (Fig. 4). Many of these cells lack the starch and tannins seen with SEM in other neighboring cells; cytoplasmic remnants can be observed with SEM, however (Fig. 4, above).

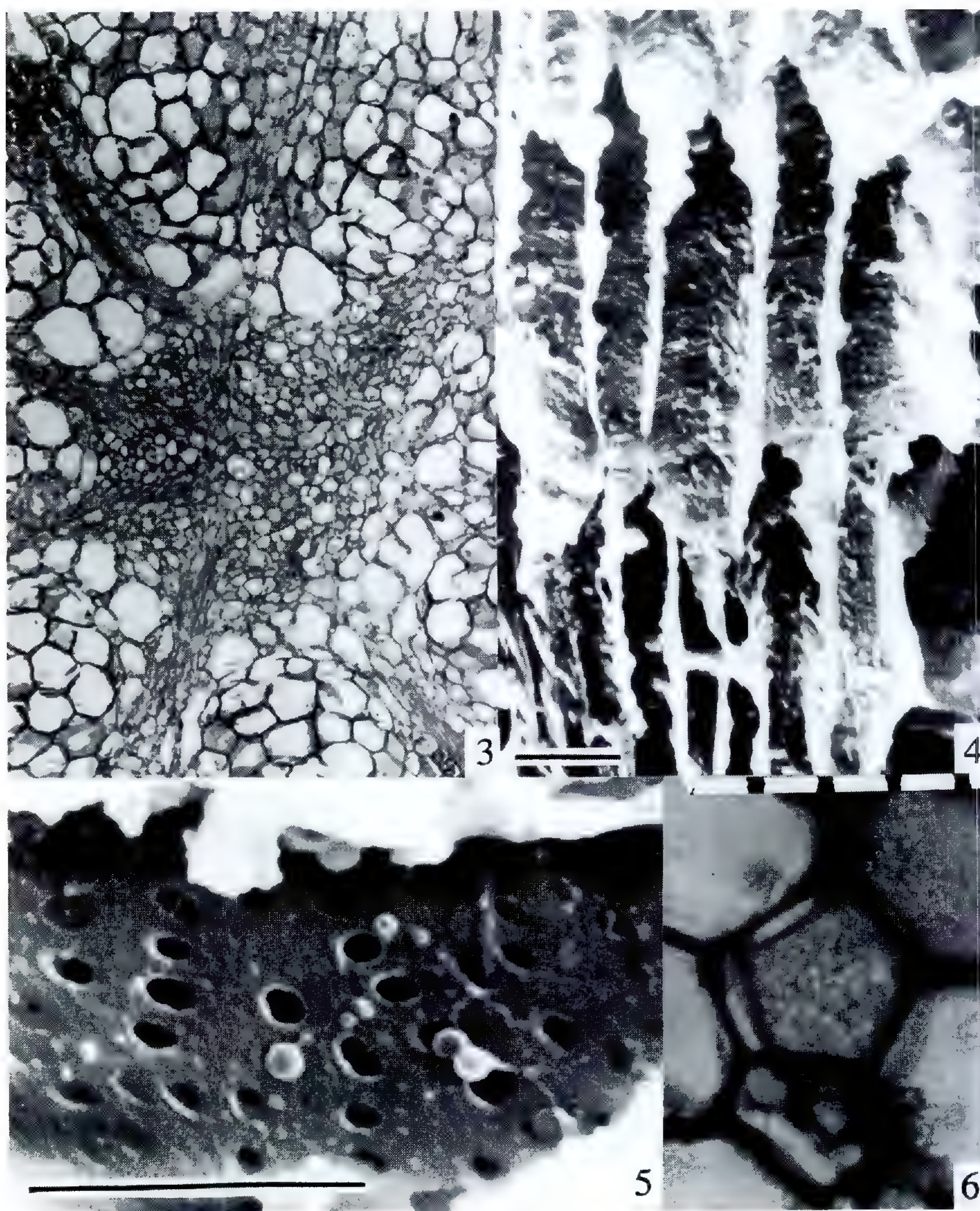
Neither in the main stem nor in the lateral stems did we see the features ordinarily used to identify primary xylem annular, helical, or reticulate bands of secondary wall superimposed on a primary wall. With SEM, one cannot find small pores in primary walls, invisible with light microscopy, that indicate presence of vessels by virtue of the porose walls (e.g., *Barclaya*, Schneider and Carlquist 1995). Xylem can be said to be present only by



FIGS. 1–2. Sections of mature main stem of *Ceratophyllum demersum*. Fig. 1. Transection of stem, showing cortex delimited from vascular core by a circle of air canals; smaller air canals are evident within the vascular core. Arrows indicate presumptive endodermis between the large air canals. Fig. 2. Median longitudinal section of stem; the main air canals are interrupted at the nodal plate, middle of photograph; smaller air canals adjacent to the nodal plate extend into branches. Figs 1–2, divisions = 10 μ m in magnification scales.

designating the central portion of the core as xylem, as Jones (1931) did, although even he had reservations about doing so. Because neither light microscopy nor SEM reveal any structural characteristics of tracheary elements in this region, we prefer to consider that *Ceratophyllum* lacks xylem.

Sieve-tube elements and companion cells (Figs. 5, 6) are present in the vascular core, usually more commonly around the periphery than in the center. The sieve plates are simple (Figs. 5, 6), with clearly defined pores that are densely placed and more uniform in size than primary pit field pores (Figs. 5, 6). Sieve-tube elements are generally narrower in diameter than the parenchyma cells they accompany, and are not organized into strands or groupings that one expects in phloem strands of stems. For this reason, we do not use the term “phloem parenchyma” as Jones (1931) did. Endress (1994) reports phloem, but no xylem, in floral structures.



FIGS. 3–6. Sections from mature stem of *Ceratophyllum demersum*. Fig. 3. Transection of nodal plate, showing strands of elongate cells extending into bases of lateral branches. Fig. 4. SEM photograph of elongate cells from longisection of lateral branch; remnants of cytoplasm are present on wall surfaces. Fig. 5. SEM photograph of sieve plate of a sieve-tube element from a transection of the main stem. Fig. 6. Sieve tube element (sieve plate in face view) surrounded by parenchyma cells, from transection of vascular core of the main stem. Fig. 4, scale as in Fig. 1; Figs. 4–5, scale bars = 10 μm . Fig. 6, scale divisions = 10 μm .

DISCUSSION AND CONCLUSIONS

The nature of sieve-tube elements in *Ceratophyllum* is of potential phylogenetic interest, because the sieve-tube elements and their associated companion cells in *Ceratophyllum* correspond to the most specialized phylogenetic condition according to the criteria of Zahur (1959) for woody dicotyledons and Cheadle and Whitford (1941) for monocotyledons. These authors have considered that sieve-tube elements with little differentiation between end wall and lateral wall in morphology of sieve areas, and with no companion cells derived from the same initial as the sieve-tube element, are primitive in dicotyledons and monocotyledons. The genus *Austrobaileya* has been cited as exemplifying this condition (see Metcalfe 1987). However, transverse partitioning in a sieve-tube element may result in end walls bearing simple sieve plates in a dicotyledon with vessels with long scalariform perforation plates in xylem, as in *Cercidiphyllum* (Zahur 1959), and thus sieve-plate morphology may not be a reliable key to degree of phyletic advancement. Also, one can find simple sieve plates with conspicuous pores in peduncles of *Victoria* (Schneider 1976) and other Nymphaeaceae; this may be a byproduct of conductive rates, rather than phyletic status (Carlquist 1975). However, whatever the criteria used, the sieve-tube elements of *Ceratophyllum* do not show a condition that one would call primitive for dicotyledons.

The status of sieve-tube elements is placed first in this discussion because the sieve-tube elements of *Ceratophyllum* do not suggest an incipient stage in the evolution of that cell type. Therefore, one would be tempted to consider the absence of xylem in *Ceratophyllum* to be secondary, a loss or reduction related to adaptation to the submersed habit rather than indicative of a primitive status among angiosperms. If vegetative structures of *Ceratophyllum* are typically submersed, there is little selective value for conduction of water from one part of the plant to another. However, there is, in flowering plants, a selection for phloem because the location of photosynthesizing organs is almost always at a distance from sites for active storage of photosynthates—the fruits (or, in some plants, tubers or other storage organs). Although there is no xylem in the species of *Ceratophyllum*, studied herein there are elongate cells other than sieve-tube elements in the vascular core of stems. Such elongate cells could conceivably serve for moderate degrees of water conduction.

Of prime importance in discussing the probability that xylem was present ancestrally but has been lost is the primary xylem of *Brasenia* (Schneider and Carlquist 1996). In *Brasenia*, annular or helical thickenings of secondary wall material are present at tips of tracheary elements. However, on lateral walls of the tracheary elements of *Brasenia*, these thickenings are reduced to inconspicuous ridges, visible only with SEM, that lack

lignification. *Brasenia* thus offers an example of a stage in reduction of xylary cells with relation to adaptation to the aquatic habitat. Although xylem reduction has been suggested for aquatic plants by a number of authors, likely stages in reduction (other than reduction in quantity of tracheary elements) have not been demonstrated for tracheary tissue of genera other than *Brasenia*.

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NEW SPECIES OF *ARDISIA* (MYRSINACEAE) FROM ECUADOR AND PERU

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ABSTRACT

Routine determination of specimens received as gift for determination resulted in the discovery of four new species of *Ardisia*, from Ecuador and Peru. *Ardisia premontana* Pipoly, *A. zakii* Pipoly, *A. flavida* Pipoly, and *A. websterii* Pipoly are described, illustrated, and their phylogenetic relationships are discussed.

RESUMEN

Al determinar pliegos de herbario recibidos como regalo para su determinación, se encontraron cuatro especies nuevas pertenecientes al género *Ardisia*, y procedentes de Ecuador y Perú. Se describen e ilustran *Ardisia premontana* Pipoly, *A. zakii* Pipoly, *A. flavida* Pipoly, y *A. websterii* Pipoly, y se discuten sus relaciones filogenéticas.

INTRODUCTION

The genus *Ardisia* Swartz is pantropical and contains approximately 400–500 species (Chen Cheih & Pipoly 1996). There are two geographic regions with high concentrations of species, Panama and adjacent Colombia, and the Malesian area (Stone 1982, 1989, 1990, 1992). The genus is currently defined by the combination of mostly bisexual flowers, pluriseriate ovules (many times appearing uniseriate because of high anthotaxis), quincuncial, imbricate, or contorted corolla, relatively long style and often punctiform or apiculate stigma. Clearly, the entire tribe is badly in need of revision on a worldwide scale, because generic delimitation is often controversial and inconsistent even within a region. In the Neotropics, Aublet (1775), Urban (1922), Ducke (1930), and Lundell (1963, 1964, 1981a, 1981b, 1981c, 1981d, 1982) have segregated various groups from *Ardisia* as distinct genera, while in the Paleotropics, several genera have been synonymized (Stone 1993a, Larsen & C. M. Hu 1995, Miller & Pipoly 1993, Taton 1979). Finally, Stone (1993b) described one new Asian subgenus, *Scherantha*. At this time, a phylogenetic analysis of the tribe will be necessary to resolve the usually disparate classifications recognized in the Americas, Africa, Asia and the Pacific. Therefore, for the taxa I have described from those areas, (Miller & Pipoly

1993; Pipoly 1991a, 1991b, 1992, 1994a, 1994b, 1995) I recognized as few segregates as possible (such as *Ctenaridisia* Ducke, *Gentlea* Lundell, *Synardisia* Lundell, and *Solonia* Urban for the Neotropics) and define the rest of *Ardisia* broadly, by informally recognizing a number of infrageneric groups. Routine determination of specimens sent as gift for determination from the many Andean exploration programs of the Missouri Botanical Garden resulted in the discovery of the following novelties, described herewith.

***Ardisia premontana* Pipoly, sp. nov. (Fig. 1)**

Propter laminas magnas chartaceas ellipticas vel oblongas atque ad apices breviacuminatas, inflorescentiam terminalam bipinnatipaniculatamque, pedicellos obsoletos vel subobsoletos, margines sepalinos hyalinos, necnon antera paullo super basin dorsifixi, *A. albovirenti* valde arcte affinis, sed ab ea ramulis dense rufo-furfuraceo lepidotis (non glabris) angulatis vel subteretibus (nec teretibus), petiolis canaliculatis (non marginatis) 1.5–2.5 (nec 0.8–1.5) cm longisque, inflorescentia 17–19 (non 5–7.5) cm longa, calyce cupuliforme (non cotyliforme), lobis calycinis carinatis (non planis) glandulari-granulosis (nec glabris) ad apices obtusis (nec late rotundatis) secus margines glabris subintegris erosisque (nec integerrimis glandulari-ciliolatis), corolla 4–4.5 (non 5–6) mm longa irregulariter dividitque, lobis corollinis ovatis cucullatisque (non ellipticis planisque), filamentis antheris longioribus (non) subaequalioribus), antheris ad apices acutis (non aliquantam emarginatis), denique ovario obnapiformi (non ovoideo) praeclare distat.

Tree to 10 m tall. *Branchlets* angulate to subterete, 5–7 mm diam., densely rufous furfuraceous lepidote, early glabrescent. *Leaves* alternate; blades chartaceous, elliptic or oblong, 23.5–30.6 cm long, (8–)9–10.5(–11.7) cm wide, apically short-acuminate, the acumen ca. 0.5 mm long, basally acute to cuneate, slightly asymmetric, decurrent on the petiole, midrib canaliculate above, prominently raised below, smooth and sordid above, sparsely and minutely rufous lepidote below, glabrescent, densely but inconspicuously red punctate and punctate-lineate, secondary veins 36–48 pairs, notable but not prominent above and below, the margin entire, irregular, flat, glabrous; petiole canaliculate, 1.5–2.5 cm long, densely and minutely furfuraceous lepidote tomentellous, glabrescent. *Inflorescence* terminal, pyramidal, bipinnately paniculate, 17–19 cm long, 11–24 cm wide, the rachis deeply angulate, densely rufous glandular-granulose, the branches spicate; inflorescence bract unknown; peduncle 1–1.5 cm, floral bracts membranaceous, linear, 1–1.2 mm long, 0.2–0.3 mm wide, cucullate, apically obtuse, densely glabrous above, glandular-granulose below, sparsely red punctate, the margin entire, glabrous; pedicels subobsolete to obsolete. *Flowers* 5-merous, chartaceous, yellow, 4–4.5 mm long; calyx narrowly and deeply cupuliform, 2.2–2.5 mm long, the tube 1–1.5 mm long, the lobes symmetric, ovate, 1–1.2 mm long,

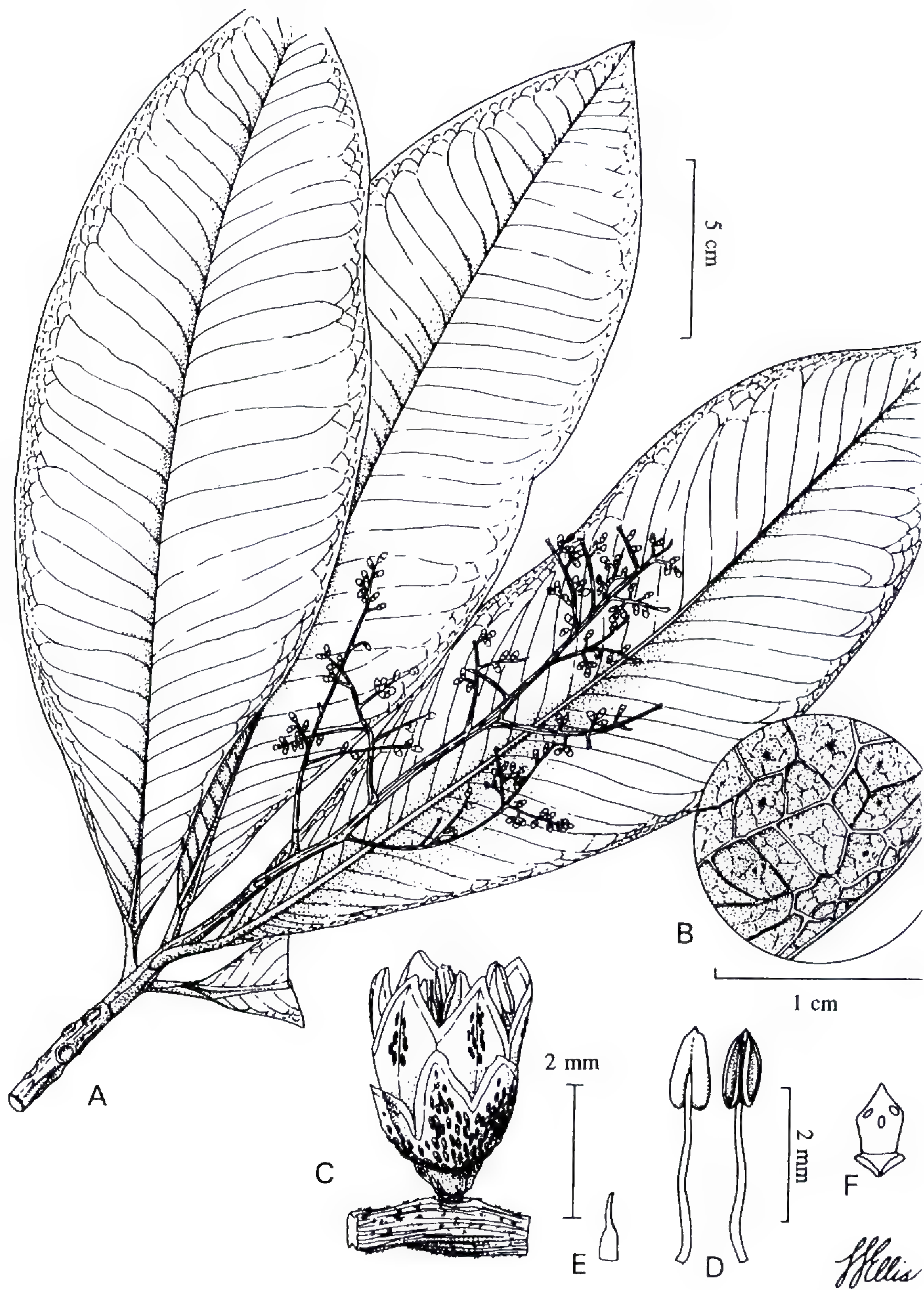


FIG. 1. *Ardisia premontana* Pipoly. A. Habit. B. Abaxial leaf surface, showing minute rufous lepidote scales. C. Flower, showing obsolete pedicel, cupuliform calyx with ovate lobes and campanulate corolla. D. Stamens, showing anthers with acute, apiculate apices. E. Pistil. F. Placenta, showing biseriate ovules. A–F, drawn from holotype.

0.6–1 mm wide, apically obtuse, medially carinate, minutely glandular-granulose, densely and prominently red punctate and punctate-lineate medially, the margin subentire except erose apically, hyaline, glabrous; corolla campanulate, 4–4.5 mm long, tube 1.8–2 mm long, the lobes irregularly divided, ovate, 2.2–2.6 mm long, 0.8–1 mm wide, hyaline, apically acute, somewhat cucullate, glabrous throughout, the margins entire; stamens 3.5–3.8 mm long, the filaments free, terete, glabrous, hyaline, 2.6–2.9 mm long, the anthers elliptic, 1.4–1.6 mm long, 0.7–0.8 mm wide, apically acute, apiculate, basally obtuse, dehiscent by wide longitudinal slits, the connective epunctate; pistil obnapiform, 1.5–1.7 mm long, the ovary globose, 0.6–0.8 mm wide, densely and prominently red punctate, the placenta turbinate, ovules 3–4, biseriate, the style 0.9–1.2 mm long, the stigma truncate. *Fruit* unknown.

TYPE: PERU. HUÁNUCO: La Divisoria, Tingo María-Pucallpa road near Loreto border, ca. 09°05' S, 75°50' W, 1,150–1,250 m, 29 Mar 1977 (fl), A. Gentry, D. Daly & S. Cruz 18804 (HOLOTYPE: MO; ISOTYPES: BRIT, F, USM).

PARATYPE: ECUADOR. MORONA-SANTIAGO: Bomboiza, 17 km SE of Gualaquiza, 03°27' S, 78°34' W, 700 m, Jul–Oct 1985 (fl), J. Zaruma 315 (MO, NY, QCNE).

Distribution.—Known only from the eastern slopes of the Andes of southern Ecuador and central Peru, at 700–1,250 m elevation.

Ecology and conservation status.—*Ardisia premontana* occurs in the species-rich premontane forests of the lower eastern slopes of the Andes, at the rim of the Amazon Basin. The Tingo María area is well-known for its many endemic species, yet still remains underexplored. Because *Ardisia premontana* is known only from two specimens, no determination of its conservation status is possible at this time.

Etymology.—The specific epithet refers to the habitat of *Ardisia premontana*, premontane moist forest.

Ardisia premontana is most closely related to *Ardisia albovirens* Mez (including *A. nigrovirens* MacBride), by virtue of its large, chartaceous, elliptic or oblong leaves with acute apices, the terminal bipinnate panicles, obsolete to subobsolete pedicels, hyaline sepal margins, and anthers dorsifixed just above the base. However, *Ardisia premontana* is clearly separated from *A. albovirens* by the densely rufous furfuraceous lepidote and angulate or subterete branchlets, the canaliculate, longer petioles, longer inflorescence, cupuliform calyx with carinate, glandular-granulose lobes with obtuse apices and glabrous subentire and erose margins, the shorter corolla irregularly divided with ovate, cucullate lobes, the filaments longer than the anthers, the anthers apically acute, and the obnapiform ovary. *Ardisia premontana* is best placed in subgenus *Ardisia*, because of the longitudinally dehiscent anthers, pyramidally paniculate, terminal inflorescence with spicate branches, symmetric calyx lobes and truncate stigma.

***Ardisia zakii* Pipoly, sp. nov. (Fig. 2)**

Quoad ramulos crassos usque ad 1 cm diametros, folia magna coriaceaue, petiolos usque ad 3 cm longos, *A. carchianae* similans, sed ab ea ramulis angulatis longitudinaliter alatis (non teretibus), foliis alternis (non pseudoverticillatis), petiolis teretibus marginatisque (non canaliculatis), laminis desuper perpuncticulis scrobiculatisque (non epunctatis laevibusque) subter manifeste minuteque atro-punctatis atque atro-punctato-lineatis (nec obscure pellucido-punctatis), secus margines revolutis (nec planis), ad bases obtusis (nec acutis), inflorescentia rameali (non terminali), secus rhachides epunctatas (non atro-punctato-lineatas), lobis calycinis depresso-ovatis auriculatisque (non linearilanceolatis symmetricisque), ovario pentangulo (non tereti), necnon in sylvas montanas nebulosasque (non premontanas) incolens, perfacile cognoscitur.

Tree 8 m tall. *Branchlets* sharply angulate, ca. 1 cm diam., with longitudinal wings along the angles, glabrous, the pith hollow. *Leaves* alternate; blades coriaceous, very widely elliptic, 28–31 cm long, 15–16.5 cm wide, apically widely rounded with a small acute tip, basally obtuse, decurrent on petiole to base, nitid and glabrous above and below, perpuncticulate and scrobiculate above, smooth, black punctate and punctate-lineate below, the midrib flat above, prominently raised below, secondary veins 26–30 pairs, tertiary veins prominent above and below, margin entire, revolute, glabrous; petiole almost terete, prominently marginate, 2.5–3 cm long, glabrous. *Inflorescence* ramigerous, pyramidal, paniculate, 9–16 cm long, 7–10 cm wide; peduncle 3–4 cm long; rachis glandular-papillate, glabrescent; the branches spicate; inflorescence bracts unknown, floral bracts unknown; pedicel obsolete. *Flowers* 5-merous, coriaceous 5.2–5.9 mm long; calyx cupuliform, 1.8–2 mm long, the tube ca. 0.6–0.8 mm long, the lobes asymmetric and auriculate, depressed-ovate, 1–1.2 mm long, 1.2–1.4 mm wide, apically broadly rounded, basally rugose, the margin scarious, minutely erose apically, sparsely glandular-ciliolate, glabrescent; corolla rotate, 5.2–5.9 mm long, tube 5-angled, 3–3.3 mm long, the lobes deltate, 2–2.6 mm long and wide, reflexed 180° at anthesis apically acute, densely but inconspicuously pellucid punctate-lineate, the margin irregular, hyaline, glabrous; stamens 3.5–4 mm long, the filaments flat, hyaline, 2.2–2.5 mm long, glabrous, the anthers lanceolate, 1–1.2 mm long, 0.8–1 mm wide, apically apiculate, basally cordate, dehiscent by wide longitudinal slits; pistil lageniform, 5–5.3 mm long, the ovary ellipsoid, 5-angled, 3–3.5 mm long, 1.5 mm diam., the style curved, 1.5 mm long, the ovules 5–8 in 2–3 rows, the stigma subcapitate, 3-lobed. *Fruit* globose, 5–7 mm diam., black at maturity, inconspicuously pellucid punctate.

TYPE: ECUADOR. PICHINCHA: Carretera Quito-San Juan Chiriboga-Empalme, Km 59, 16 km NW of road, 1,700–2,000 m, 23 Sep 1986 (fl, fr), V. Zak 1298 (HOLOTYPE: MO; ISOTYPES: BRIT, QCNE).

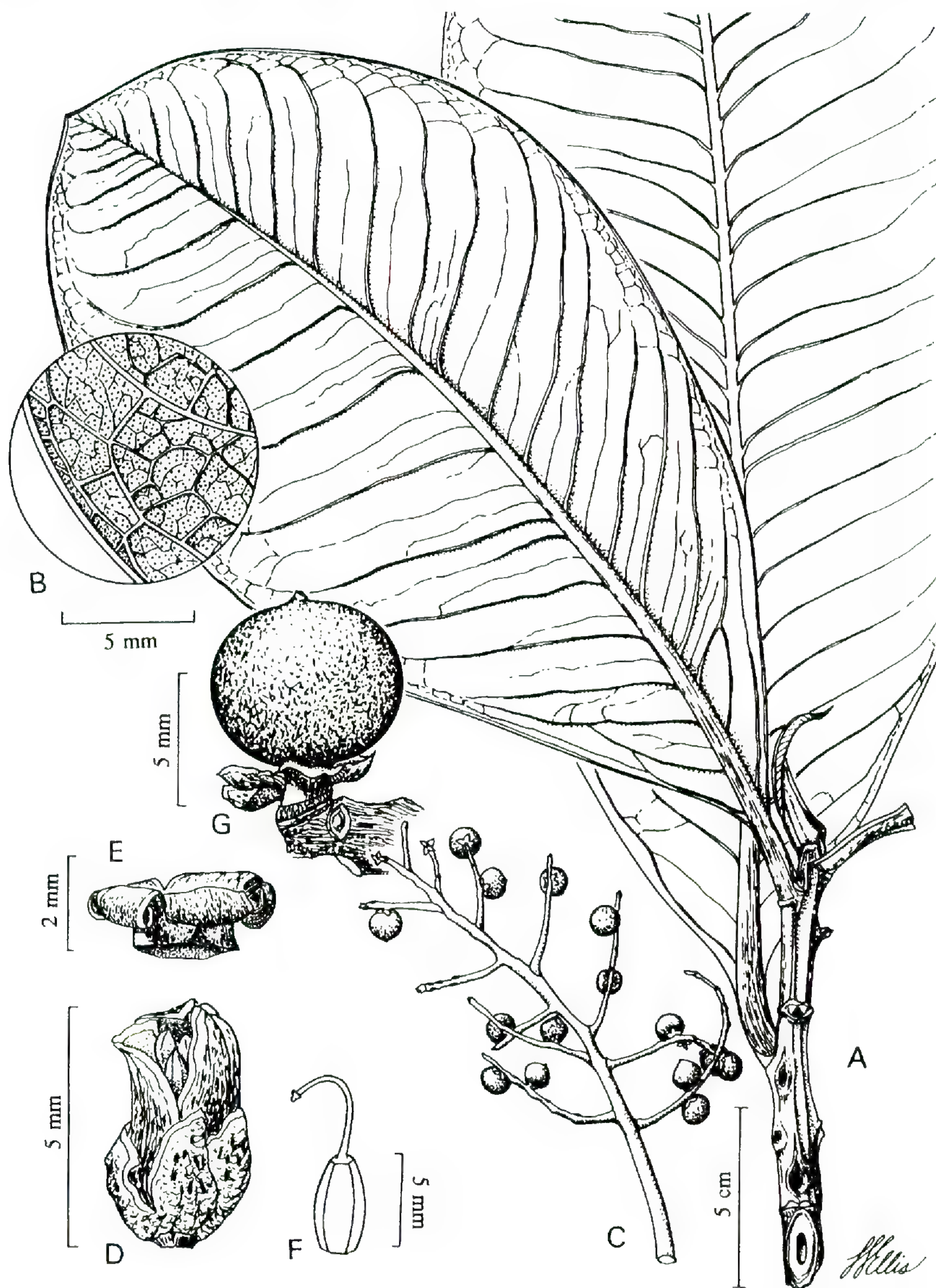


FIG. 2. *Ardisia zakii* Pipoly. A. Habit, showing winged branchlet. B. Detail of abaxial leaf surface, showing prominent tertiary veins. C. Portion of inflorescence, showing spicate branches. D. Flower bud, showing depressed-ovate calyx lobes and corolla lobes with hyaline margins. E. Corolla at anthesis, showing angled tube and reflexed lobes. F. Pistil, showing angled ovary and subcapitate stigma. G. Fruit. A–G, drawn from holotype.

Distribution.—Known only from the type.

Ecology and conservation status.—*Ardisia zakii* occurs in remnant cloud forests on steep slopes. With increasing forest destruction as roads are further developed, this species should be considered threatened.

Etymology.—It is with great pleasure that I dedicate this species to Vlastimil Zak, former collector and participant in the Missouri Botanical Garden's program of botanical exploration in Ecuador.

Ardisia zakii is most closely related to *Ardisia carchiana* Lundell, but is easily recognized by the angulate, longitudinally alate branchlets, marginate, terete petioles, the leaf blades with obtuse bases, adaxially perpuncticulose and scrobiculate, abaxially black punctate and punctate-lineate, the margins revolute, the pentangular ovary and the depressed-ovate, auriculate calyx lobes. The auriculate calyx lobes and lanceolate, longitudinally dehiscent anthers indicate placement in the group of *Ardisia* often segregated as *Auricularidisia* Lundell. The group has its center of diversity in Panama, with high concentrations of species also in Colombia.

Ardisia flavida Pipoly, sp. nov. (Fig. 3)

Ob ramulos angulatos crassosque, folia magna alternaque, lamina desuper perpuncticulosa costa canaliculata, petiolos usque ad 2.5 cm longos, inflorescentiam pyramido-bipinnatipaniculatam, pedicelos obsoletos, calycem cupuliformem, lobos calycinos secus margines erosos glabrosque, corollae lobos oblongos vel ellipticos, filamentia teretia, *A. monsalvae* valde arcte affinis, sed ab ea ramulis glabris (non ferrugineo-stellato-tomentosis), petiolis subteretibus marginatisque (non canaliculatis), floribus flavidos (non eborinos), lobis calycinis 1–1.2 (non 0.8–1) mm longis minute rufo-lepidotis (nec rufo-puberulis) lobis corollinis carinatis (nec planis) ad apices planis (nec cucullatis) pellucido- (nec atro-)punctato-lineatis secus margines crenulatis (nec erosis), filamentis glabris (non dense rufo-papillosis), antheris ovatis (non linearis) ad apices apiculatis (nec emarginatis), denique stigmate capitato (non puntiforme) statim separabilis.

Shrub 4 m tall. *Branchlets* angulate, trigonal, 5–7 mm diam., glabrous. *Leaves* alternate; blades coriaceous, oblanceolate to elliptic, 19–25 cm long, 9–11.8 cm wide, apically widely rounded, shortly subacuminate, 3–5 mm long, basally obtuse, decurrent on the petiole, nitid and sparsely perpuncticulose above, pallid and inconspicuously black punctate below, midrib canaliculate above, prominently raised below, the secondary veins 25–36, margin entire, flat, scarious, glabrous; petiole subterete, marginate, 1.5–2.5 cm long, flat above, glabrous. *Inflorescence* terminal, pyramidal paniculate, 10–21 cm long, 8–16 cm wide at base; peduncle obsolete to 4 mm long; rachis sharply angulate, densely and minutely rubiginous glandular-granulose, the branches spicate; inflorescence, branch and floral bracts apparently early caducous, unknown; pedicels obsolete. *Flowers* membranaceous, yellow, 4–4.5 mm long; calyx deeply cupuliform, 3–3.4 mm long, unequally divided, the tube 1.3–1.5 mm long, the lobes slightly asymmet-

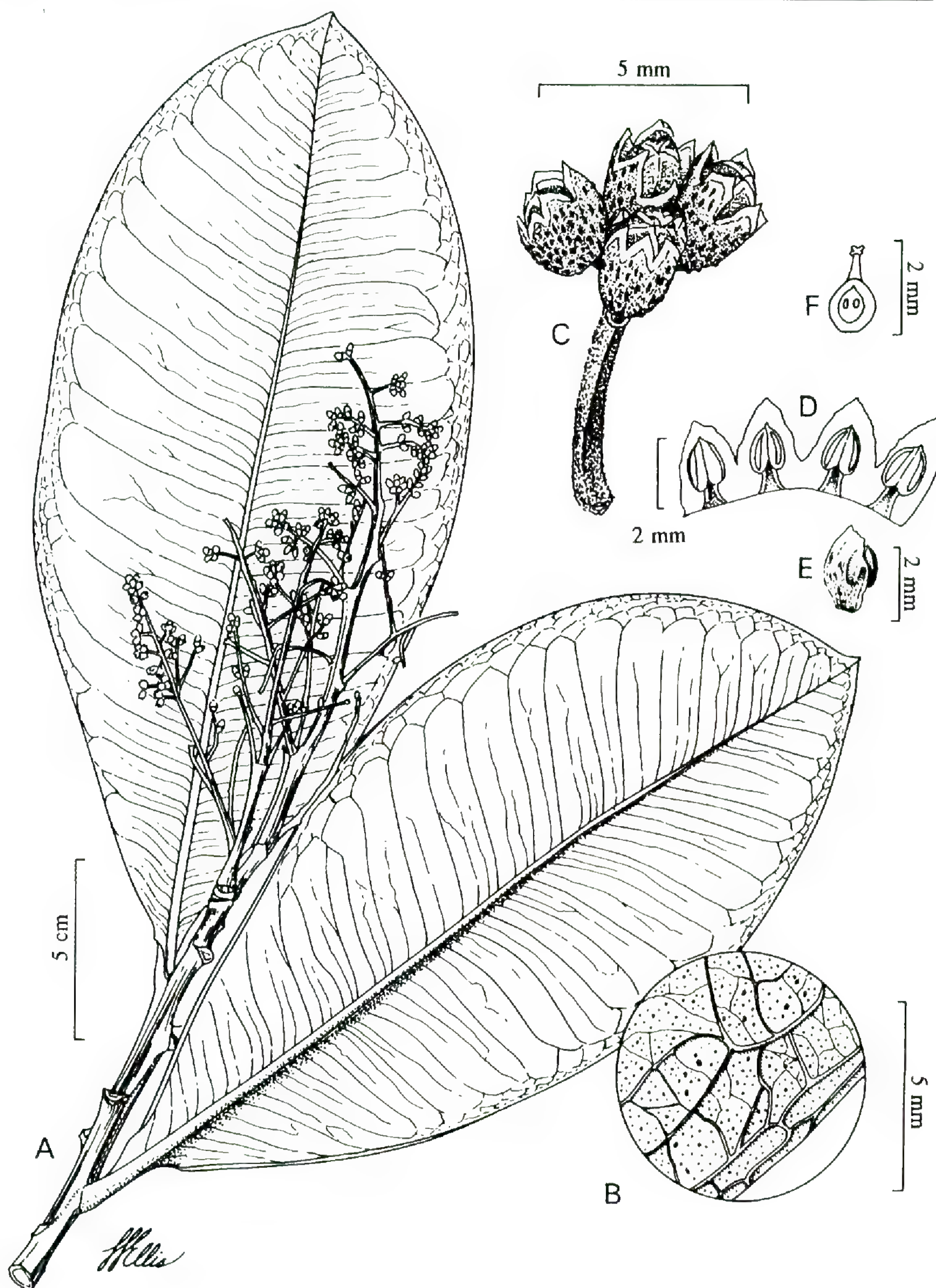


FIG. 3. *Ardisia flavida* Pipoly. A. Habit, showing terminal inflorescence and angulate branchlet. B. Detail of abaxial leaf surface, showing inconspicuous black punctations. C. Flower cluster at tip of inflorescence rachis branchlet. D. Open corolla, showing minutely crenulate margins, and apiculate anthers. E. Corolla lobe, showing medial ridge. F. Pistil, showing placenta and apparently uniseriate ovules. A–F, drawn from holotype.

ric, oblong, 2–2.2 mm long, 1.6–1.8 mm wide, apically obtuse to rounded, densely and prominently black punctate and punctate-lineate, densely and minutely rufous lepidote, hyaline, margin entire, scarious; corolla campanulate, 3–3.3 mm long, the tube 0.8–1 mm long, the lobes oblong to elliptic, 2–2.3 mm long, 0.9–1.1 mm wide, apically acute, hyaline, medially carinate, pellucid punctate and punctate-lineate, the margins minutely crenulate, glabrous; stamens 2–2.2 mm long, the filaments flat, 0.9–1.2 mm long, inserted at corolla base, hyaline, the anthers ovate, 1–1.3 mm long, 0.6–0.8 mm wide, subversatile, apically apiculate, basally cordate, dehiscent by large longitudinal slits, the connective epunctate; pistil obnapiform, 2–2.3 mm long, the ovary globose, 1–1.2 mm long and diam., the placenta depressed-globose, ovules 4, pluriseriate in a high spiral, thus appearing uniseriate, the style 0.8–1.1 mm long, the stigma capitate, 4-lobed. *Fruit* unknown.

TYPE: ECUADOR. ESMERALDAS: Canton San Lorenzo, 10 km SW of Lita, going up to the El Cristal Sector; 00°48' N, 78°30' W, 800 m, 10 Sep 1990 (fl bud), D. Rubio & C. Quelal 664 (HOLOTYPE: MO; ISOTYPES: BRIT, QCNE).

Distribution.—Known only from the type.

Ecology and conservation status.—*Ardisia flavida* occurs at the limit of lowland forest with premontane forest. The forests of Esmeraldas form part of the Chocó Floristic Province, contiguous with the Cordillera Occidental of Colombia, an area that receives some of the highest rainfall known in tropical ecosystems. The coastal forests of Ecuador have very few old growth forest stands left, and thus, this species, along with its habitat, should be considered endangered.

Etymology.—The specific epithet refers to the yellow color of the flowers, a rarity among members of the genus.

The thick, angulate branchlets and large, alternate leaves with peripunctulose blades and canaliculate costa, the petioles up to 2.5 cm long, and pyramidal bipinnately paniculate terminal inflorescence, obsolete pedicels, cupuliform calyx with lobes erose and glabrous along the margins, oblong to elliptic corolla lobes, and terete filaments, indicate that *Ardisia flavida* is most closely related to *Ardisia monsalvae* of Colombia. However, the glabrous branchlets, subterete petioles, yellow flowers, the longer, minutely rufous lepidote calyx lobes, the carinate, pellucid punctate-lineate corolla lobes with flat apices and crenulate margins, the glabrous filaments, ovate, apiculate anthers and capitate stigma permit easy separation. The terminal panicles with spicate branches, and apiculate anthers dehiscent by wide longitudinal slits indicates that *Ardisia flavida* is best placed in subgenus *Ardisia*, despite the fact that the style is not long and does not have a punctiform stigma. Clearly, the entire tribe is in great need of revision.

***Ardisia websterii* Pipoly, sp. nov. (Fig. 4)**

Quoad ramulos stellato-tomentosos, filamenta longa, anthera lineari-lanceolata ad apices emarginata, necnon pedicelos obsoletos, *A. monsalveae* accedens, sed ab ea trunco uniaxiali (non multiaxiali), vestimento ramulino foliarique rufo- (non ferrugineo-) stellato-tomentoso, foliis pseudoveriticillatis (non alternis), laminas ad bases semiauriculatis (non acutis), inflorescentia axillari (non terminali), lobis calycinis suborbicularibus (non ellipticis) ad apices late rotundatis (nec obtusis), lobis corollinis lineari-lanceolatis (non ellipticis) ad apices planis (nec cucullatis), filamentis glabris (non rufo-papillosis), denique stigmata capitata (non punctiforme) praeclare distinguitur.

Monoaxial tree (Corner's Architectural Model *sensu* Hall et al. 1978) to 3 m tall. *Branchlets* terete when fresh, drying angular, 8–12 mm diam., densely and minutely rufous stellate-tomentose, the tomentum persistent. *Leaves* pseudoveriticillate; blades chartaceous, widely oblanceolate, (48–)52–60 cm long, 17–22 cm wide, apically acuminate, the acumen 3–4 cm long, gradually tapering to a truncate, semiauriculate base, midrib slightly elevated but canaliculate above, prominently raised below; sordid and glabrescent above, pallid and sparsely stellate pubescent below, tomentose along the secondary veins, inconspicuously pellucid punctate and punctate-lineate, the margin roughly sinuate-dentate, the tooth vascularized; petiole canaliculate, obsolete to 5 mm long, glabrous above, densely stellate tomentose below. *Inflorescence* lateral (axillary), at times produced in whorls between major whorls of leaves, a columnar thyse 9–15(–20) cm long, 3–6 cm wide; peduncle 1.5–3 cm long; inflorescence bract foliaceous, membranaceous, oblong, 3–3.5 cm long, 1–1.2 cm wide, apically broadly rounded, gradually tapering to cuneate base, sparsely stellate tomentose above and below, densely and prominently black punctate and punctate-lineate, the margin entire, glabrous; secondary branch bracts foliaceous, membranaceous, oblong, 1.5–2.5 cm long, 0.4–0.6 cm wide, apically rounded, basally cuneate, otherwise like inflorescence bract; floral bracts membranaceous, linear, 3.2–3.5 mm long, 0.8–1 mm wide, apically narrowly acute to subulate, cucullate, hyaline, densely and prominently black punctate, very sparsely stellate tomentose below, the margin entire, glabrous; pedicel obsolete. *Flowers* 5-merous, membranaceous, pale pink, 5–6 mm long, hyaline; calyx cupuliform, 2.5–3.5 mm long, irregularly divided, tube 1.4–1.7 mm long, the lobes suborbicular, 1–1.8 mm long and wide, apically broadly rounded, densely punctate and punctate lineate medially, very sparsely lepidote, the margin hyaline, minutely erose, glabrous; corolla rotate, 5.5–6 mm long, the tube 2–2.4 mm long, the lobes linear lanceolate, 3.1–3.4 mm long, 0.7–1 mm wide, apically acute, hyaline, glabrous, the margin entire; stamens free, 6–6.6 mm long, exserted or anthers appearing versatile, the filaments free, 4.6–5 mm long, inserted at corolla base and adnate to 0.3 mm, hyaline, glabrous, the anthers linear-lanceolate,

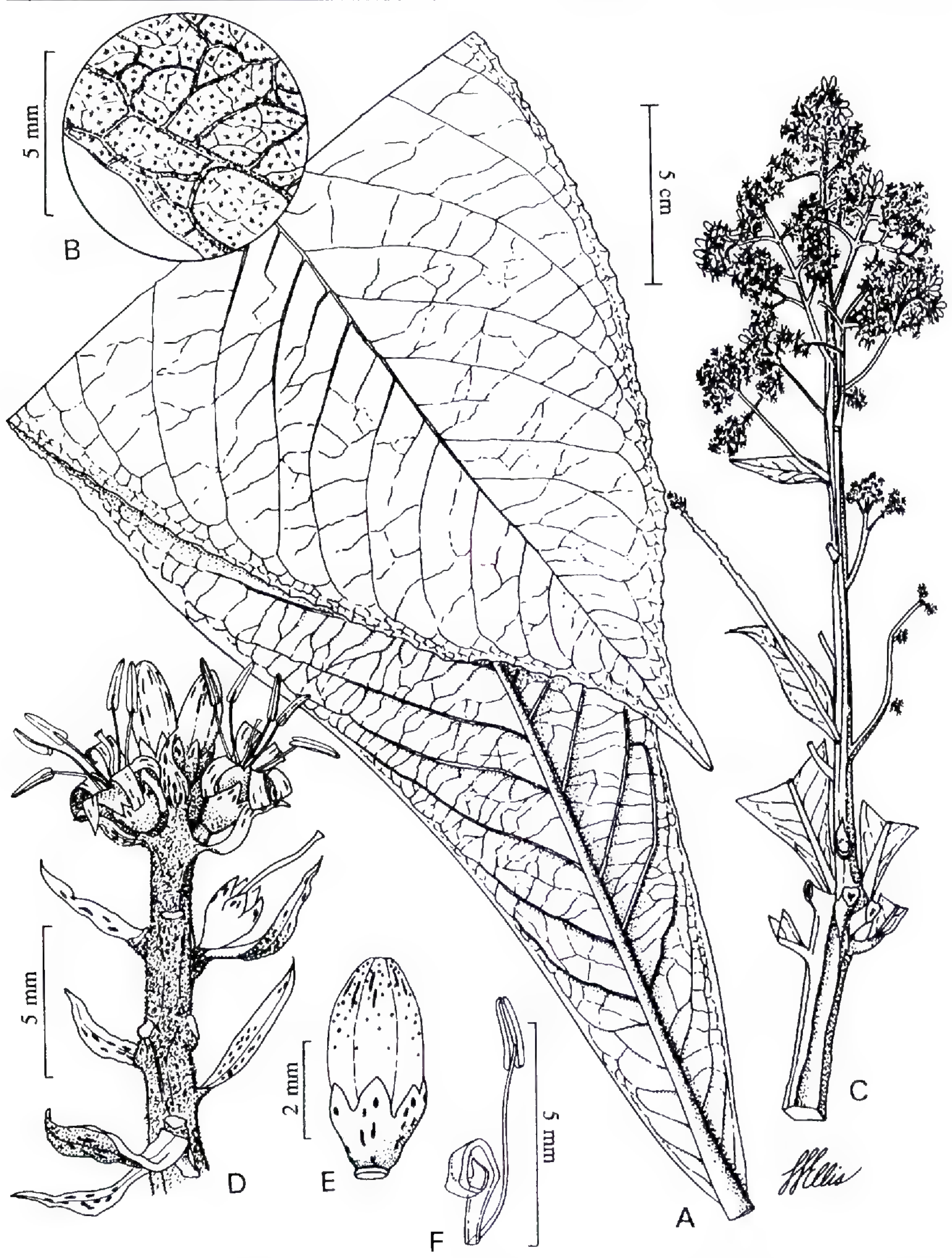


FIG. 4. *Ardisia websterii* Pipoly. A. Leaf, showing sinuate-dentate margin. B. Detail of abaxial leaf surface, showing stellate-tomentum. C. Inflorescence, showing leaflike bract and columnar thyrse morphology. D. Portion of inflorescence, showing floral bracts. E. Flower bud, showing cupuliform calyx and punctations. F. Corolla lobe and stamen, showing relative lengths of each. A–F, drawn from holotype.

2.1–2.8 mm long, apically narrowly acute to a minutely emarginate tip, basally deeply sagittate, dorsifixed ca. 1/3 from base, dehiscent by large longitudinal slits, the connective epunctate. Pistil obturbinate, 4.8–5.5 mm long, the ovary subglobose, 1–1.2 mm long, 0.7–0.9 mm wide, densely black punctate, glabrous, the style tortuous, 3.5–3.8 mm long, the placenta subglobose, the ovules 3–5, appearing uniseriate, the stigma subcapitate, 3–4 lobed. *Fruit* unknown.

TYPE: ECUADOR. PICHINCHA: Canton Quito; Parroquia Nanegal; Maquipucuna Protected Forest; 5 km airline SE of Nanegal, E side of río Tulambi, 00°06' N, 78°37.5' W; 1,350–1,400 m, 5 Sep 1993 (fl), *G. Webster* 30307 (HOLOTYPE: BRIT; ISOTYPES: DAV, QCNE).

PARATYPES: ECUADOR. PICHINCHA: Canton Quito; Parroquia Nanegal; Maquipucuna Protected Forest; 6 km airline SE of Nanegal, along trail from Río Umachaca to Loma Sta. Lucia, 00°07' N, 78°37' W; 1,675 m, 6 Sep 1993 (fl), *G. Webster et al.* 30361 (BRIT, DAV, QCNE), 5 km airline SE of Nanegal, above Río Tulambi, 1,550 m, 00°7.5' N, 78°38.5' W, 1,550 m, 31 Aug. 1993 (fl), *G. Webster et al.* 30009 (DAV, QCNE).

Distribution.—*Ardisia websterii* appears to be endemic to the Maquipucuna Forest Reserve, Ecuador, at 1,350–1,675 m elevation.

Ecology and conservation status.—This species is a conspicuous element of the montane rainforest understory, growing on streambanks, just above high water marks. The Maquipucuna Forest Reserve seems well-protected at this time, so *Ardisia websterii* may be considered not under threat.

Etymology.—This species is named for Grady L. Webster, curator of the John M. Tucker Herbarium of the University of California at Davis and pre-eminent authority on the systematics of neotropical Euphorbiaceae.

Ardisia websterii with a monoaxial trunk and pseudoverticels of inflorescences, exhibits Corner's Architectural Model (Hallé et al. 1978). At first glance, it has the aspect of several members of *Cybianthus* subgenera *Wegeltia* and *Comomyrsine*, but the glabrous petals, long, free, exserted stamens, and anthers with deeply sagittate bases indicate placement in the genus *Ardisia*. While *Ardisia websterii* does not easily fit into any known subgenus of *Ardisia*, description of a new one is postponed until more neotropical species of the genus have been examined. *Ardisia websterii* approaches *A. monsalveae* in several aspects, most notably because of the stellate tomentum, long filaments, linear-lanceolate anthers with minutely emarginate tips and the obsolete pedicels. However, *Ardisia websterii* is easily distinguished from *A. monsalveae* by the rufous vestiture, the pseudoverticillate, basally auriculate leaves, axillary inflorescence, suborbicular calyx lobes with broadly rounded apices, the linear-lanceolate corolla lobes with flat apices, the glabrous filaments and capitate stigma. Clearly, more study is needed of the entire large-leaved group of *Ardisia* in the Andes.

ACKNOWLEDGMENTS

The Missouri Botanical Garden's exploration programs in Ecuador and Peru, headed by Dr. David Neill and Ing. Rodolfo Vásquez, respectively, continue to produce fine quality specimens from remote, poorly known and often dangerous areas. Their gifts sent to BRIT for determination made the present study possible, along with those of Dr. Grady Webster, of the University of California at Davis. The fine line illustrations were prepared by Ms. Linda Ellis with her usual knack for simplicity and accuracy.

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NEW SPECIES OF *GEISSANTHUS* (MYRSINACEAE) FROM THE HYLAEA/ANDEAN INTERFACE OF ECUADOR AND PERU

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ABSTRACT

Routine determination of specimens received as gift for determination resulted in the discovery of three novelties in *Geissanthus*. *Geissanthus vanderwerffii* Pipoly, *G. spectabilis* Pipoly and *G. challuayacus* Pipoly are described, illustrated and their phylogenetic relationships are discussed.

RESUMEN

Al determinar muestras recibidas como regalos para su determinación, se encontraron tres especies nuevas, pertenecientes al género *Geissanthus*. Se describe, se ilustra y se discute el parentesco de *Geissanthus vanderwerffii* Pipoly, *G. spectabilis* Pipoly y *G. challuayacus* Pipoly.

INTRODUCTION

The genus *Geissanthus* was circumscribed by Hooker (Bentham & Hooker 1876) to include 10 taxa from the Andes, which he did not list. The only reference to a taxon was made indirectly, by listing *Fendler 759*, a specimen of *Geissanthus fragrans* Mez. Mez (1902) distinguished *Geissanthus* from the other genera of the tribe Myrsineae by its free stamens, dorsifixed anthers, and the calyx closed in bud, opening later into irregular lobes. In that treatment, 25 species were recognized, of which 17 were new. We must assume, therefore, that at least eight of the taxa described as new by Mez had actually been seen previously by Bentham, but remained undescribed. Subsequently, miscellaneous new species were added to the genus by Mez (1905, 1920), MacBride (1934) and Cuatrecasas (1951).

Agostini (1970) was the first worker since Mez to discuss generic delimitation among taxa assigned to *Conomorpha* A. DC., and *Stylogyne* A. DC. Agostini distinguished *Geissanthus* from *Stylogyne* and what was at that time the *Cybianthus* Martius complex of genera (including *Conomorpha* A. DC., *Weigeltia* A. DC., *Comomyrsine* Hooker) based on a combination of several characters, including: the terminal inflorescence; sessile or subsessile flowers; calyx lobes closed in bud, then rupturing into 2–8 unequal lobes

on the same inflorescence; corolla lobes fused 1/3 or more of their length; and a capitate stigma. Using those criteria, he transferred three taxa from *Conomorpha*, and one taxon from *Stylogyne*, to *Geissanthus*.

My previous studies (Pipoly 1993) and the present one reconfirm that *Geissanthus* may best be defined by its unique calyx, closed in bud and opening into 2–8 usually unequal lobes, the corolla with linear, oblong or rarely ovate lobes that are distally recurved at least 180° in anthesis, and the subversatile or versatile anthers which are latrorsely dehiscent by wide or narrow longitudinal slits. *Stylogyne* may easily be separated from *Geissanthus* by its contorted corolla, with the lobe tips highly twisted in bud. *Cybianthus* (including *Comomyrsine* Hooker, *Conomorpha* A.DC., *Correlliana* D'Arcy, *Grammadenia* Bentham, *Microconomorpha* (Mez) Lundell, and *Weigeltia* A. DC., see Pipoly 1987, 1992) may be separated from *Geissanthus* by its axillary inflorescences, stamens connate by their filaments to form a tube, the staminal tube adnate to the corolla tube, and the glandular granules present at least at the junction of the corolla lobes and tube. Using these criteria to determine generic limits, Pipoly (1993) transferred three species into *Geissanthus* and described an additional four species. Those seven taxa, and the three novelties described here, bring the total number of species recognized in *Geissanthus* to 45. Because I disagree with the placement of *Stylogyne ambigua* (Martius) Mez in *Geissanthus* (Agostini 1970), the genus is entirely Andean except for populations of *Geissanthus perpuncticulosus* (Lundell) Pipoly occurring in the Darién of Panama. Members of the genus are mostly known from moist, wet and pluvial premontane, montane, and cloud forests, and less frequently from subpáramo thicket formations. They are moderate trees, usually less than 15 m tall, with very conspicuous terminal, paniculate inflorescences. Quantitative studies of Andean forests I have conducted in Colombia indicate that they generally occur in populations smaller than 20 individuals per hectare, at least in the mid-level stratum of the montane and cloud forests. My qualitative observations from Ecuador and Peru have thus far confirmed the statistics observed in Colombia.

Determination of gift specimens received from the Missouri Botanical Garden, in connection with their floristic studies in Ecuador and Peru, resulted in the discovery of the following novelties, described herewith. Morphological terminology follows Pipoly (1993) and Lindley (1848).

***Geissanthus vanderwerffii* Pipoly, sp. nov. (Fig. 1)**

Quoad ramulos angulatos glabrosque, folia alterna, petiolos marginatos, lamina secus margines integerrima, inflorescentiam folias longitudine aequantiam vel subaequantiam, corollam campanulatam, necnon lobos corollinos retrocurvatos, *G. ecuadorensi* valde arcte affinis, sed ab ea laminis coriaceis (non cartilagineis) desuper scrobiculatis (nec laevibus)

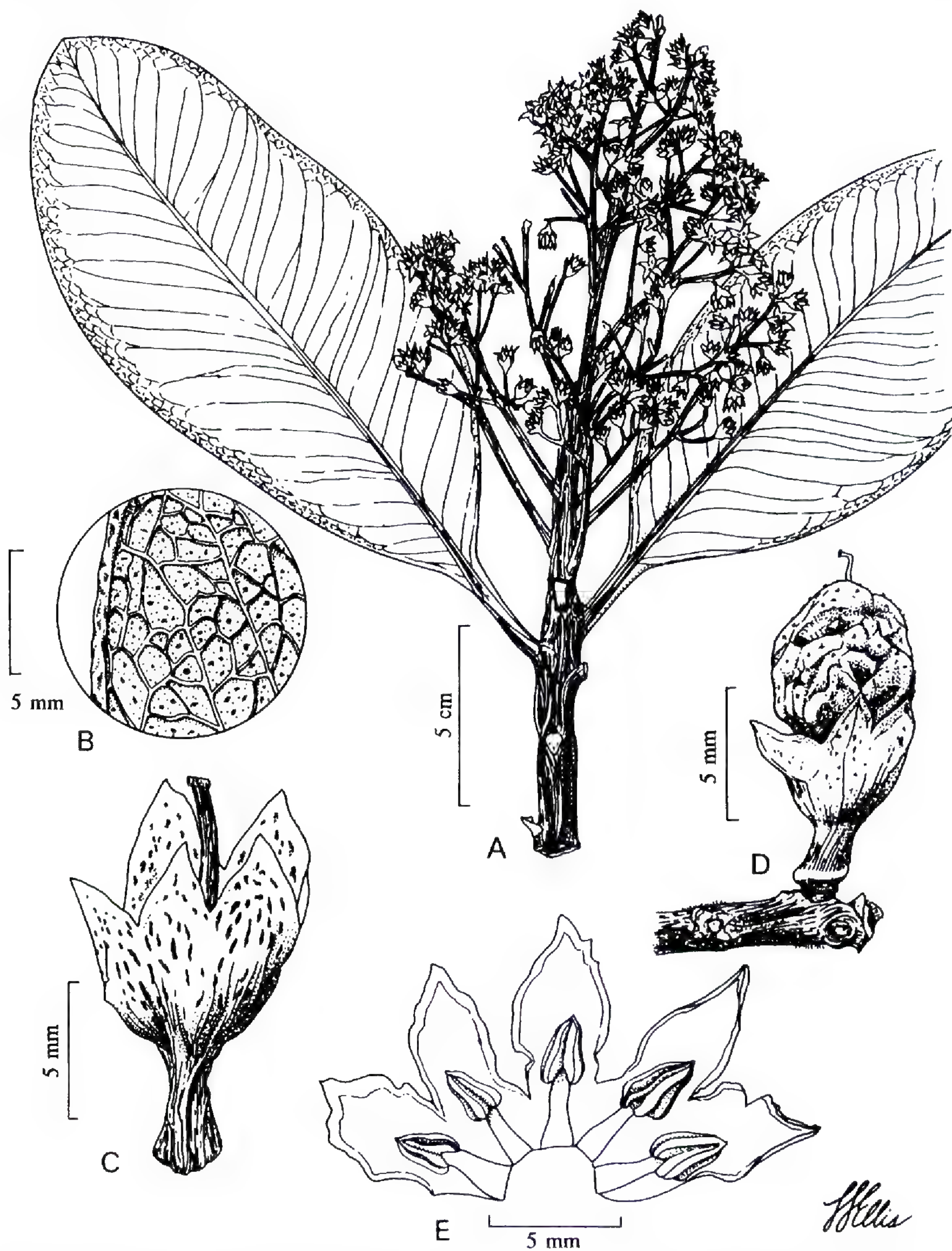


FIG. 1. *Geissanthus vanderwerffii* Pipoly. Habit, showing the angled branchlets and pedicellate flowers. B. Abaxial leaf surface detail, showing the dense and minute pellucid punctations. C. Flower with corolla removed, showing the pedicel, and the cupuliform calyx with entire lobes. D. Young fruit. E. Opened corolla, showing the apiculate anthers with latrorse slits. A–C, E, drawn from holotype; D, drawn from *vanderwerff* 8965.

subter glabris (nec lepidotis) dense minuteque pellucido-punctatis (nec epunctatis), inflorescentiis polygamis (non bisexualis), pedicelis 3–5.6 mm longis (non obsoletis), flores 7–9 (non 3–5.6) mm longis, calyce cupuliformi (non cotyliformi) in fructo spissesscenti (nec in statu eodem reliquo), lobis calycinis ovatis vel deltatis (non suborbicularibus) rufo-papillosis (nec glabris) 2.5–3.5 (nec 1.8–2.2) mm longis secus margines opacis integrisque (nec hyalinis erosisque), lobis corollinis ad apices anguste vel late acutis (non rotundatis), denique antheris ad apicem acutis (non rotundatis) perfacile cognoscenda.

Tree to 6 m tall. *Branchlets* angulate, 4.5–10 mm diam., glabrous. *Leaves* alternate; blades coriaceous, widely oblong to obovate, (9.8–)11–15.5(–18.2) cm long, (4.4–)6–7.2(–8.5) cm wide, apically obtuse, widely rounded or rarely truncate, basally obtuse to truncate, decurrent on the petiole, dull, glabrous, minutely scrobiculate above, densely and minutely pellucid punctate below, the midrib flat to slightly impressed above, prominently raised below, the secondary veins 22–27 pairs, the margin entire, revolute, glabrous; petiole marginate, 1.8–2.5 cm long, glabrous. *Inflorescence* terminal, pyramidal, bipinnately or mixed paniculate, (7.5–)9–12 cm long, 8–15 cm wide at base, polygamous, the flowers staminate and bisexual, monomorphic; peduncle 0.5–1 cm, angulate, glabrous or very sparsely and minutely rufous papillate, the branches with flowers corymbose; inflorescence, branch and floral bracts apparently early caducous, unknown; pedicels cylindric, 3–5.6 mm long, sparsely pellucid punctate-lineate, glabrous or very sparsely and minutely papillate. *Flowers* chartaceous, white, 7–9 mm long; calyx deeply cupuliform, 5.5–7 mm long, 3–6 lobed, irregularly divided, the tube 2.8–4.9 mm long, sparsely rufous papillate, pellucid or orange punctate and punctate-lineate, the lobes widely ovate to deltate, 2.5–3.5 mm long, 2.1–3.5 mm wide, apically narrowly to broadly acute, the margin entire, opaque, glabrous; fruiting calyx incrassate obconic, 6.6–6.5 mm long, 6–6.3 mm diam.; corolla campanulate, 7–9 mm long, 5-lobed, the tube 3.5–4.2 mm long, the lobes, ovate, 3.5–4.8 mm long, 2.8–3.5 mm wide, apically acute, reflexed 180° at maturity, densely and prominently orange or pellucid punctate, glabrous, the margin entire, slightly involute, glabrous; stamens 5 in staminate flowers, 7.5–8 mm long, the filaments free, 6–6.5 mm long, subterete, the anthers ovate, 1.8–2.5 mm long, 0.9–1.4 mm wide, apically obtuse with prominent apiculum, basally deeply cordate, dehiscent by wide latrorse longitudinal slits, the connective epunctate; stamens of bisexual flowers like those of staminate but 4.2–4.5 mm long, the filaments free, 2.1–2.4 mm long, widened basally 1–1.2 mm, flat, adnate 0.8–1 mm above corolla tube basae, translucent, epunctate, glabrous, the anthers 2.1–2.4 mm long, 1.4–1.7 mm wide; pistil of bisexual flowers obnapiform, 5.3–5.8 mm long, the ovary 2.6–3 mm long, 3–3.5 mm diam., densely pellucid punctate, glabrous, the placenta depressed-globose, the ovules 3–5, uniseriate; the style 2.5–

2.7 mm long, pellucid punctate-lineate, glabrous, the stigma capitate, 4-lobed; pistillode similar to pistil but 3.5–4 mm long, the ovary 1.2–1.5 mm long, the ovules obsolete, the style 2.3–2.9 mm long, the stigma capitate, unlobed. *Fruit* globose, 6–8 mm diam., inconspicuously pellucid punctate.

TYPE: ECUADOR. ZAMORA CHINCHIPE: along old trail from Nudo de Sabanilla to Valladolid, 2,300 m, 6 May 1987 (bisexual fl), *H. van der Werff* & *W. Palacios* 9374 (HOLOTYPE: US; ISOTYPES: BRIT, MO, QCNE).

PARATYPES: ECUADOR. ZAMORA-CHINCHIPE: Canton Zamora; Parque Nacional Podocarpus, near el Tambo, 40 km NW of Zamora on road to Loja, 03°58'S, 79°07'W, 2,210 m, 13 July 1993 (fr), *A. Gentry* 79920 (MO, QCNE); Yangana-Valladolid Rd., km 21, 04°28'S, 79°09'W, 2,650–2,750 m, 2 Dec 1988 (stam. fl), *J. Madsen, C. Bloch* & *H. Christensen* 75794 (AAU, BRIT, QCA).

Distribution.—Endemic to the south-central Andes of Ecuador, in open elfin forest or scrub, at 2,200–2,750 m elevation.

Ecology and conservation status.—*Geissanthus vanderwerffii* forms a conspicuous element of the cloud forest vegetation, even though it is a component of the understory (van der Werff, pers. comm.). Because sizeable populations of this species occur in a national park located in a somewhat remote area, it is not currently under threat.

Etymology.—It is with great pleasure that I dedicate this spectacular new species to Henk van der Werff, head of the Taxonomy Department at the Missouri Botanical Garden. Henk is a prodigious, indefatigable field worker and pre-eminent authority on the systematics of Neotropical Lauraceae.

The angled branchlets, alternate leaves with entire blades, marginate petioles, the inflorescence equalling or subequalling the leaf length, and the campanulate corolla indicate that *Geissanthus vanderwerffii* is most closely related to *Geissanthus ecuadorensis* Mez. However, the coriaceous leaf blades scrobiculate above, densely and minutely pellucid punctate and glabrous below, the polygamous inflorescence with longer pedicels and larger flowers, the cupuliform calyx incrassate in fruit, and with ovate to deltate, rufous-papillate lobes that are entire and opaque along the margins permit easy recognition of *G. vanderwerffii*. In addition, the narrowly to widely acute corolla lobe apices are distinctive. The incrassate (thickening with maturity) fruiting calyx is unique within the genus.

Geissanthus spectabilis Pipoly, sp. nov. (Fig. 2)

Propter ramulos ad apices angulatos furfuraceo-lepidotos, folia pseudoverticillata, lamina chartacea anguste vel late oblanceolata ad apices acuminata, secus margines integerrima plana, glabraque, petiolos canaliculatos desuper glabros subter furfuraceo-lepidotos, inflorescentia terminalia pyramidalia, flores membranaceos, lobos calycinos ad apices acutos secus margines integros glabrosque, corolla campanulata, necnon lobos corollinos lineares *G. longistamineo* valde arcte affinis, sed ab ea ramulis pentangularibus (nec irregulariter angulatis mature teretibus) sine granulis glanduares (nec glandulari-granulosis), laminis

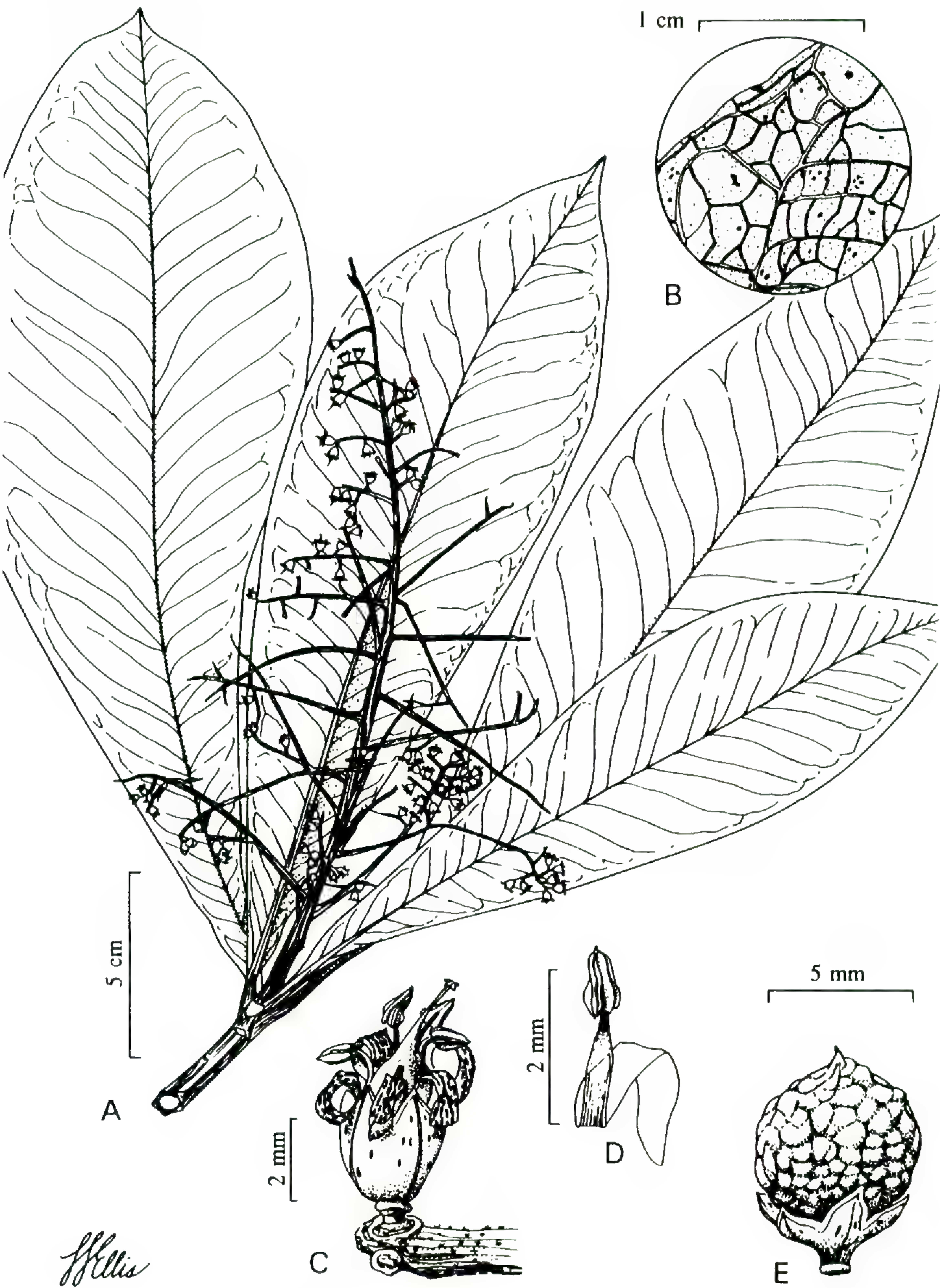


FIG. 2. *Geissanthus spectabilis* Pipoly. A. Habit, showing the angulate branchlets and pseudoverticillate leaves. B. Abaxial leaf surface detail, showing scattered rufous furfuraeous lepidote scales. C. Flower, showing acute calyx lobes and linear corolla lobes. D. Dissected corolla lobe and attached stamen, showing prominent anther apiculum. E. Fruit. A–D, drawn from holotype; E, drawn from *Smith 4172*.

ad bases acutis (non abrupte truncatis) subter obscure pellucido-punctatis punctato-lineatisque (nec manifeste atro punctato-lineatis), panicula tri- (non bi-) pinnata, pedicellis obsoletis (non obconicis 0.2–1.3 mm longisque), floribus 3.5–4.5 (non 5.8–6.3) mm longis, filamentis planis (non teretibus), 2–2.3 (nec 4–4.5) mm longisque, antheris parce dorsifixis (non versatilis) lanceolatis (nec oblongis) 1–1.2 (nec 2.2–2.4) mm longis, ad apices apiculatis (nec obtusis) denique pistillo obnapiformi (non obturbinato) statim separabilis.

Tree to 6 m tall. *Branchlets* angulate, 7–20 mm diam., pentagonal in cross section, prominently ridged along the angles, densely and minutely ferruginous furfuraceous-lepidote, glabrescent. *Leaves* pseudovercillate; blades chartaceous, narrowly to widely oblanceolate, (22.5–)29.4–36.5(–41) cm long, (7.5–)8–11.5 cm wide, apically short acuminate, the acumen 1–2 cm long, basally acute, decurrent on the petiole, drying dull and smooth above, pallid, inconspicuously pellucid punctate and punctate-lineate as well as sparsely ferruginous furfuraceous-lepidote below, the midrib impressed above, prominently raised below, the secondary veins 20–31 pairs, the margin entire, flat, glabrous; petiole canaliculate with a slight margin from decurrent leaf base, 1–1.5 cm long, glabrous above, sparsely furfuraceous-lepidote below. *Inflorescence* terminal, pyramidal tripinnately paniculate, (20–)24–38(–44.5) cm long, (13–)24–33 cm wide at basally, entirely bisexual; peduncle 0.5–1 cm long, the rachis angulate, densely and minutely furfuraceous-lepidote, glabrescent, the branches spicate; inflorescence, branch and floral bracts apparently early caducous, unknown; pedicels obsolete. *Flowers* membranaceous, 3.5–4.5 mm long; calyx deeply cupuliform, 2.5–3.5 mm long, (3–)4–5-lobed, irregularly divided, tube 1–2.5 mm long, lobes ovate to deltate, 1–1.3 mm long, 0.6–1 mm wide, apically acute, glabrous or sparsely lepidote, densely and prominently black punctate, the margin entire, opaque, glabrous; corolla campanulate, 3.5–4.5 mm long, 5-lobed, the tube 1–1.3 mm long, the lobes reflexed 180° at maturity, linear, 2.5–3.5 mm long, apically subulate, hyaline, epunctate, glabrous, the margin entire, flat; stamens 2.8–3.3 mm long, the filaments free, flat, epunctate, glabrous, 2–2.3 mm long, adnate to corolla tube 0.8–1 mm, widened at basally, the anthers lanceolate, 1–1.2 mm long, 0.4–0.5 mm wide, apically rounded with a prominent apiculum, basally rounded, slightly dorsifixed, dehiscent by wide latrorse slits, connective epunctate; pistil obnapiform or globose, 1.5–2 mm long, the ovary globose, ca. 1 mm long and diam., densely black punctate and punctate-lineate, style slender, 0.5–1 mm long, the stigma capitate, 4-lobed, placenta globose, ovules uniseriate, 4. *Fruit* globose, black at maturity, 5–7 mm diam. when dried, pellucid or red punctate.

TYPE: PERU. JUNÍN: Prov. Chanchamayo, Fondo Romero, Pampatigre, above Sta. Ana (SE of La Merced), 11°00'S, 75°10'W, 1,500–1,700 m, 7 Mar 1985 (bisex. fl, fr), B. Stein & C. Todzia 2336 (HOLOTYPE: MO; ISOTYPE: USM).

PARATYPES: PERU. PASCO: Oxapampa Prov., along road between Oxapampa and Villa Rica, Km 7 SE from Miraflores crest, 10°37'S, 75°20'W, 11 Oct 1982 (fr), *R. Foster* 9145 (F, MO, US, USM); 5 km SE of Oxapampa, Oswaldo Müller property, 10°36'S, 75°23'W, 1,850 m, 31 Jan 1983 (fl, fr), *D. N. Smith* 3166 (MO, US, USM), 25 May 1983 (fr), *D. N. Smith* 4172 (MO, US, USM).

Distribution.—*Geissanthus spectabilis* on the eastern slopes of the Peruvian Andes, in the Departments of Pasco and adjacent Junín, 1,500–2,400 m elevation.

Ecology and conservation status.—*Geissanthus spectabilis* grows in tall “ceja de selva” forest, the cloud forest region of Andean Peru that faces Amazonia. The region is known for its high endemism (Gentry 1993) and contains approximately 57% of the total vascular plant species known for the country. *Geissanthus spectabilis* is a conspicuous element of the forest, although locally common. The late D. Smith indicated (Smith, pers. comm.) that this tree is common at the junction of the taller “ceja” with that of the shorter portion, especially at the margin of the forest along watercourses in small ravines. Given the restricted distribution it is probable that this species is threatened.

Etymology.—The specific epithet describes the aesthetically appealing aspect of the plant.

Geissanthus spectabilis is closely related to *G. longistamineus* (A. C. Smith) Pipoly by virtue of its angulate, furfuraceous lepidote branchlets, pseudovercillate, chartaceous, narrowly to widely oblanceolate leaves with acuminate apices and entire, flat margins, the terminal and pyramidal inflorescences, the chartaceous flowers with calyx lobes acute, entire and glabrous along the margin, and finally, the corolla campanulate with linear lobes. However, *Geissanthus spectabilis* may immediately be separated by its 5-angled stems, leaf blades with acute bases, obscurely pellucid punctate and punctate-lineate below, the tripinnate panicles, shorter, sessile flowers with flat, shorter filaments, the shorter anthers slightly dorsifixed, lanceolate, and apiculate, and finally the obnapiform pistil.

***Geissanthus challuayacus* Pipoly, sp. nov. (Fig. 3)**

Species haec ob lamina chartacea subter rufo-furfuraceo-lepidota, inflorescentia bisexuales, flores membranaceos, corolla campanulata, anthera lanceolata, *G. francoam* affinis, sed ab ea ramulis aliquantum teretibus (non quadrangularis) glabris (non furfuraceo-lepidotis), laminis secus margines integris (nec serratis), subter squamis lepidotis dissite praeditis (non superpositus sic a velvetem similis) indutis, petiolis 1.7–2.5 (non (2.2–)2.5–3) cm longis, corolla 4–4.5 (non 3–3.2) mm longis, lobis corollinis oblongis (nec linearis), staminibus 4–4.2 (non 2.1–2.2) mm longis, denique stigmate 4-lobato (nec puntiforme) praeclare dignoscenda.

Tree to 10 m tall. *Branchlets* somewhat angular, almost terete, 5–9 mm diam., glabrous. *Leaves* alternate; leaf blades chartaceous, oblanceolate,

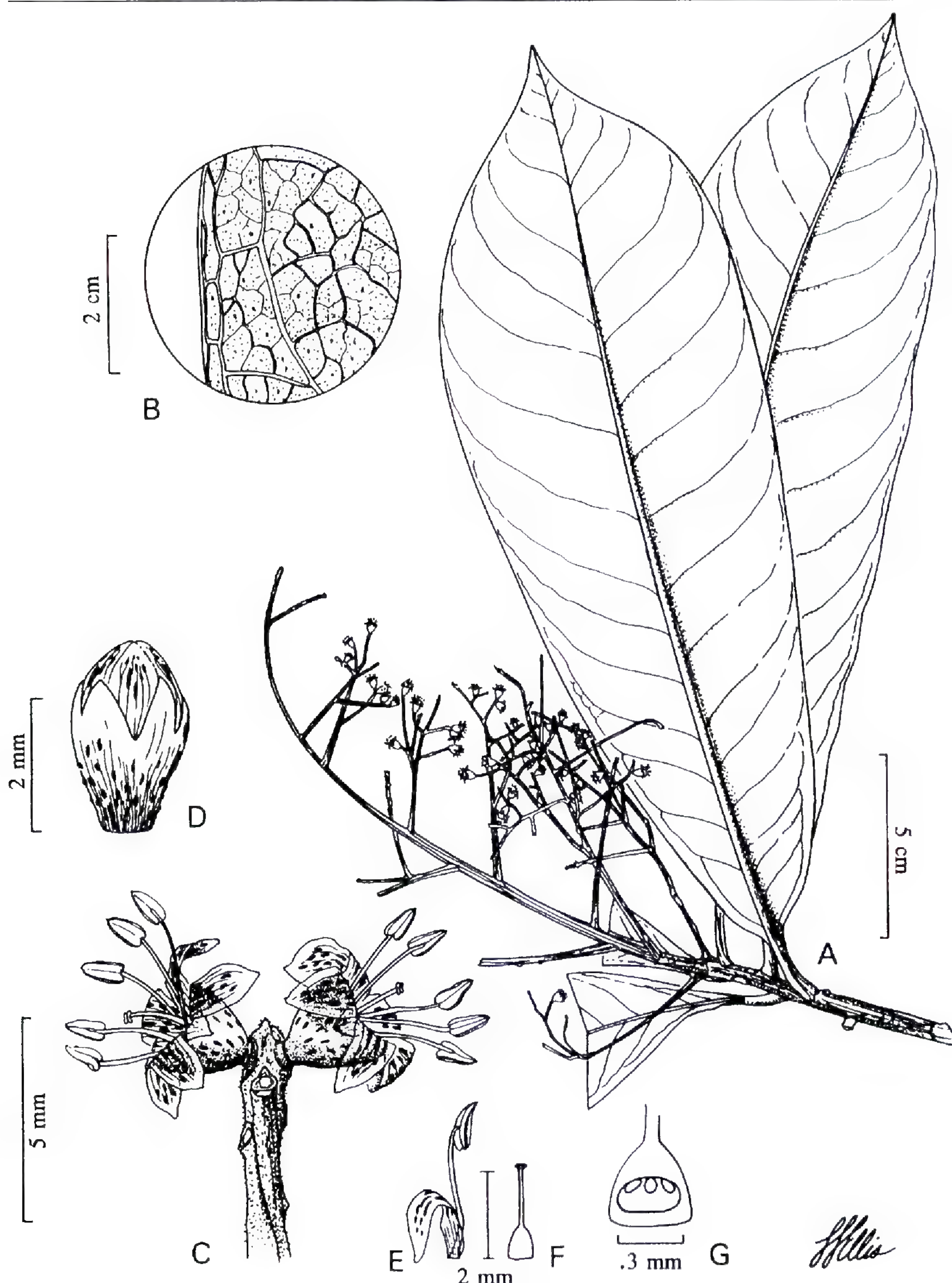


FIG. 3. *Geissanthus challuayacus* Pipoly. A. Habit, showing the almost terete branchlets. B. Abaxial leaf surface detail, showing sparse and minute lepidote scales. C. Inflorescence branchlet tip, showing obsolete pedicels. D. Partially opened flower bud, showing asymmetric rupturing of calyx. E. Dissected corolla lobe and stamen, showing flat filament adnate to corolla lobe. F. Pistil, showing capitate, lobed stigma. G. Longitudinal section of ovary, showing placenta and ovules. A, drawn from *Hurtado* 1787; B–G, drawn from holotype.

(16.8–)22–28 cm long, (4.7–)7–9(–11.8) cm wide, apically cuspidate-acuminate, the acumen 1–1.5 cm long, basally obtuse or rarely acute, decurrent on the petiole, dull and glabrous above, pallid and very sparsely and minutely rufous furfuraceous lepidote below, the midrib canaliculate above, prominently raised below, the secondary veins 16–26 pairs, essentially flat above, slightly raised below, margin entire, flat; petiole marginate, 1.7–2.5 cm long, glabrous. *Inflorescence* terminal, pyramidal bipinnately paniculate, 11.5–20 cm long, 12–28 cm wide at basally, bisexual, the branches spicate; peduncle subsessile, 3–5 mm long, glabrous; inflorescence, branch and floral bracts apparently early caducous, unknown; pedicels obsolete. *Flowers* membranaceous, greenish-white, 4–4.5 mm long; calyx deeply cupuliform, 3.2–3.5 mm long, hyaline, 3–5-lobed, irregularly divided, the tube 1.8–2.5 mm long, angular, the lobes ovate, 1.4–1.6 mm long, 1.2–1.4 mm wide, apically acute, densely and prominently black punctate and punctate-lineate, the margin irregular, entire, glabrous; corolla campanulate, 4–4.5 mm long, 4–5-lobed, hyaline, regularly divided but highly variable, the tube 1.2–2.5 mm long, the lobes oblong, 2–3 mm long, 1–1.2 mm wide, apically narrowly acute to subacuminate, cucullate, densely black punctate and punctate-lineate apically, the margin regular, entire, glabrous; stamens 4–4.2 mm long; the filaments free, flat, 2.5–3 mm long, hyaline, adnate to corolla tube 0.5 mm from base, the anthers lanceolate, 1.3–1.5 mm long, 0.3–0.5 mm wide, apically acute, at times with a minute apiculum, basally deeply cordate, dorsifixed ca. 1/3 from base, dehiscent by wide latrorse slits, the connective epunctate; pistil obturbinate, 2.2–3 mm long, 0.7–1 mm diam., the ovary globose, 1 mm long, pellucid punctate, glabrous, 1–1.2 mm long, the placenta subglobose, the ovules 4, uniseriate, exposed, the style truncate, 1.5–2 mm long, the stigma capitate, 4-lobed. *Fruit* subglobose, 5–7 mm diam., glabrous, pellucid punctate.

TYPE: ECUADOR. NAPO: Cantón Archidona; S slopes of Volcán Sumaco, Hollín-Loreto Rd, Km 131, Challua Yacu Village, 00°43'S, 77°40'W, 1,200 m, 20–25 Mar 1989 (bisex. fl), W. Palacios 4066 (HOLOTYPE, BRIT; ISOTYPES, MO, QCNE, US).

PARATYPES. ECUADOR. NAPO: Cantón Archidona; S slopes of Volcán Sumaco, Hollín-Loreto Rd, Km 25, Challua Yacu Center, 00°43'S, 77°40'W, 1,230 m, 10–19 Nov 1989 (fr), F. Hurtado & A. Alarado 891 (MO, QCNE); 00°43'S, 77°36'W, 1,200 m, 20 Mar 1989 (fl), F. Hurtado & X. Ruíz 1787 (QCNE, MO, US); Hollín-Loreto Rd, 5 km W of Guamaní, slopes of Volcán Sumaco, 00°43'S, 77°38'W, 1,200 m, 6–7 Sep 1988 (fr), D. Neill *et al.* 8574 (MO, QCNE, US).

Distribution.—Thus far, known only from the Volcán Sumaco area, along the Hollin-Loreto Rd., Province of Napo, Ecuador, from 1,200–1,230 m elevation.

Ecology and conservation status.—*Geissanthus challuayacuus* grows in lower

montane forest, on the eastern slopes of the Andes, facing Amazonia. It is presumed that, given the forest destruction present in the Napo region of Ecuador, this species may be considered threatened.

Etymology.—The specific epithet is the genitive form of the village name, Challua Yacu, Napo, Ecuador, and is thus declined as a Latin noun of the Fourth Declension.

The chartaceous leaves, furfuraceous lepidote below, bisexual inflorescences, membranous flowers with campanulate corollas and lanceolate anthers indicate that *Geissanthus challuayacuus* is most closely related to *G. francoae* Pipoly, but may be separated by the somewhat terete, glabrous branchlets, leaf blades with entire margins, sparsely lepidote undersurface, shorter petioles, longer corolla with oblong lobes, longer stamens, and 4-lobed stigma.

ACKNOWLEDGMENTS

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A NEW SPECIES OF *CAREX* (CYPERACEAE) FROM URUGUAY AND A NEW NAME IN THE GENUS

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ABSTRACT

Carex herteri (sect. *Digitatae*) is newly described from the Department of Florida in southern Uruguay and is known only from the holotype. This very distinctive, but diminutive species is characterized by having large, glabrous perigynia that are distinctly beaked, few perigynia per spike, large achenes that are strongly apiculate, and ciliate leaf margins. Additionally, the South American plants previously called *C. phalaroides* var. *crassiflora* (sect. *Digitatae*) are here raised to species rank. The name *C. gibertii* is offered for this species and a lectotype is selected.

RESUMEN

Se describe *Carex herteri* (sect. *Digitatae*) del Departamento de Florida en sur de Uruguay y sólo se conoce el holotipo. Esta especie, muy diferente aunque diminuta, se caracteriza por tener utrículos grandes y glabros, con un pico distinto, pocos utrículos por espiga, aquenios grandes fuertemente apiculados, y márgenes foliares ciliados. Adicionalmente, las plantas sudamericanas denominadas previamente *C. phalaroides* var. *crassiflora* (sect. *Digitatae*) se elevan aquí al rango específico. Se propone para esta especie el nombre *C. gibertii* y se selecciona un lectotipo.

INTRODUCTION

It is estimated that over 200 species of *Carex* L. (Cyperaceae) occur in South America (Wheeler 1996). Of those growing in the southern half of the continent, slightly under 20 have been reported from Uruguay (Osten 1931; Chebataroff 1942; Herter 1953; Pedersen 1969; Wheeler 1987, 1988). In this paper, a new species of *Carex* is reported from the Department of Florida in southern Uruguay. In addition, a new name is offered here for plants previously called *C. phalaroides* Kunth var. *crassiflora* Kük., which occur in southeastern South America.

DESCRIPTIONS AND COMMENTS

Carex herteri G. A. Wheeler, sp. nov. (Fig. 1)

Herbae laxae caespitosae, parvae; culmi ca. 2 cm alti; vaginae basales glabrae, brunneae. Folia ca. 7, plerumque basilaria, superare culmi; laminae ca. 1.5–4 cm longae, 0.8–2 mm latae, marginibus ciliatis; ligulae 0.5–1 mm longae. Inflorescentiae ca. 1.5 cm longae; spicae ca. 3, androgynae, 3–4-florae, inferiore breve pedunculatae. Perigynia 4.4–4.8 mm



FIG. 1. *Carex berteri*, habit with achene and perigynium to the right and far right of the plant, respectively (plant from the Department of Florida, Uruguay), from *Hb. Osten 19091* (*S partim*), holotype. Bar = 1 cm.

longa, 2–2.3 mm lata, acriter trigona, glabra, pallide viridis marginibus levis; rostra 0.8–1.2 mm longa. Achenium 3.3–3.5 mm longum, 1.8–2 mm latum, acriter trigoni, brunnei cum flavis anguli. Stigmata 3.

Plants loosely cespitose from short rhizomes, low-growing. Fertile culms ca. 2 cm tall, with glabrous, brownish basal sheaths. Leaves ca. 7, basal, exceeding the culms; blades ca. 1.5–4 cm long, 0.8–2 mm wide, flat or channelled proximally, the margins ciliate (but only sparingly so near the apex); leaf sheaths very short, glabrous; inner band of leaf sheaths hyaline or pale brown, glabrous; ligules 0.5–1 mm long, rounded. Inflorescences ca. 1.5 cm long, the terminal spike slightly larger than the lateral ones,

spikes strongly overlapping; lowermost bract scale-like, 3.5–5 mm long, ca. 2.5 mm wide, sheathless, with a ciliate awn ca. 0.8 mm wide and up to 2.5 cm long, the upper ones somewhat reduced. Spikes ca. 3, androgynous. Terminal spikes ca. 1 cm long; staminate portion ca. 8 mm long and 2.5 mm wide, ca. 7-flowered; pistillate portion ca. 6 mm long and 4.5 mm wide, ca. 3-flowered. Lateral spikes 5–7 mm long, on smooth peduncles up to 4 mm long; staminate portion inconspicuous, ca. 2–3-flowered; pistillate portion ca. 4–6 mm long and 4–5 mm wide, ca. 3–4-flowered. Pistillate scales exceeding the perigynia (at least the prolonged tips), the bodies 3.6–5 mm long, 1.8–2.6 mm wide, ovate-lanceolate, glabrous, pale green or stramineous center with broad, white hyaline or pale brown margins, 3-veined, the midvein prolonged into a cuspidate or sparingly aristate tip up to ca. 12 mm long. Staminate scales with bodies 3.4–4.2 mm long and 1.3–1.9 mm wide, ovate-lanceolate, glabrous, pale green or stramineous center with broad, white hyaline or pale brown margins, 3-veined, the midvein prolonged into a cuspidate or sparingly aristate tip up to 4 mm long. Perigynia 4.4–4.8 mm long, 2–2.3 mm wide, erect or somewhat spreading, strongly trigonous with slightly concave, elliptical to rhombic sides, glabrous, pale green or stramineous, 2 distinct veins and the rest obscure (however, several short veins are usually visible near the base), not inflated, the margins sharply angled and smooth, tapered to a stipitate-like base (ca. 0.6–1.2 mm long), more or less abruptly contracted into a broad beak; beaks 0.8–1.2 mm long, whitish green (especially distally), the apex entire or minutely bidentulate, the teeth (when present) weak and up to 0.1 mm long. Achenes 3.3–3.5 mm long, 1.8–2 mm wide, sharply trigonous with slightly concave, rhombic sides, closely enveloped by the perigynium, brown with yellowish angles, apiculate, sessile or nearly so. Stigmas 3. Anthers unknown.

Serendipity undoubtedly plays a role in scientific discovery. For instance, W. G. Herter apparently was not aware that he had discovered a new species when collecting plants of the commonly-occurring *Carex phalaroides*. On the herbarium sheet containing the holotype of *C. herteri* are seven plants of *C. phalaroides* and a single plant of the new species (Fig. 1).

TYPE: URUGUAY. DEPT. FLORIDA: Estancia Santa Cruz, in campis, Sep 1926, legit. W. G. Herter, *Hb. Osten 19091* (S! *partim*). The holotype is a single plant mounted in the far upper right hand corner of the herbarium sheet, where it is so marked.

Carex herteri is known only from the type locality (Fig. 2). The plant was collected “in campis” (on a plain) and has fully-developed perigynia and ripe achenes. The new species is named in honor of Wilhelm G. Herter (1884–1958), who made the type collection and who also was an indefatigable worker on the flora of Uruguay.

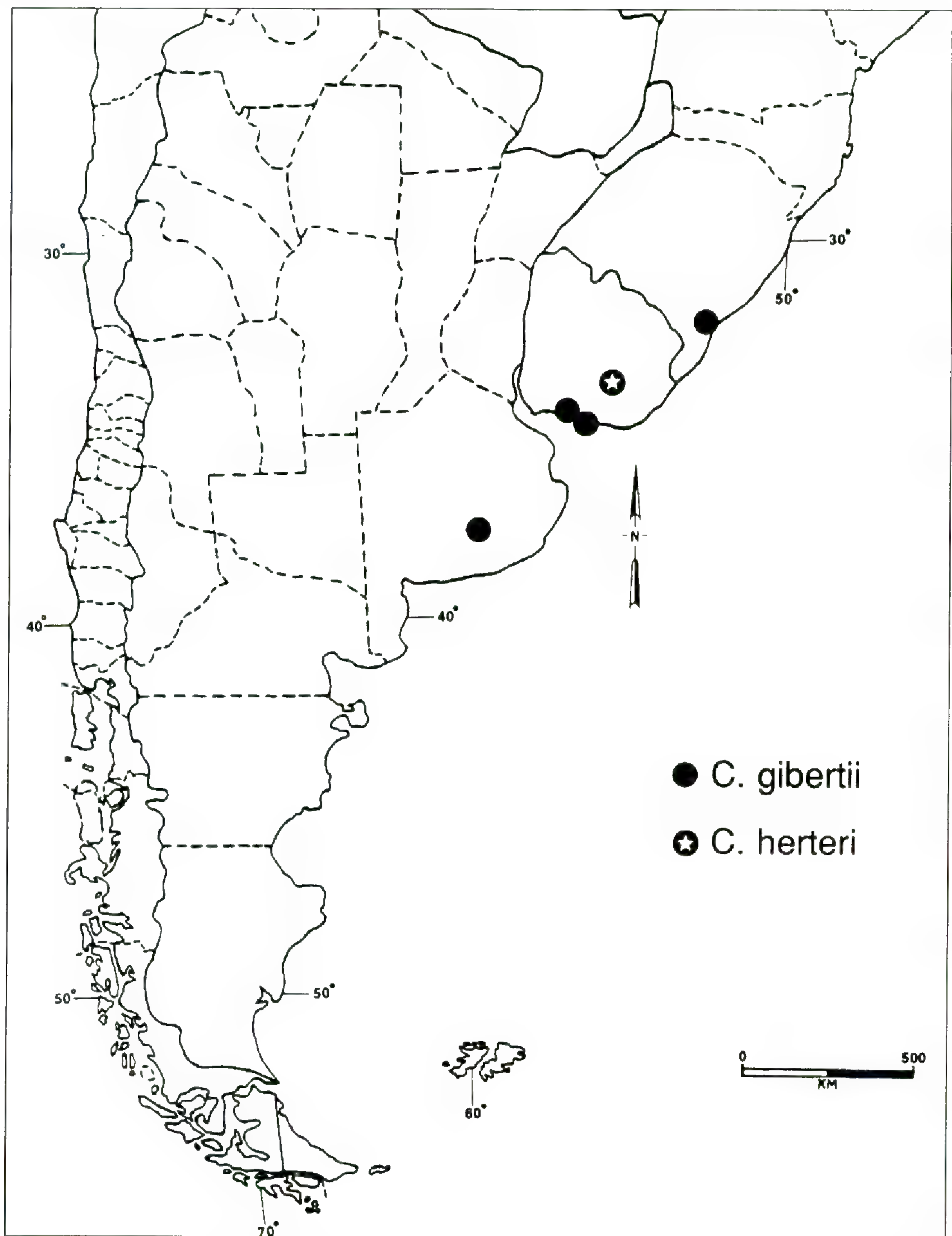


FIG. 2. Map of southern South America showing the distributions of *Carex gibertii* and *C. herteri*.

As is evident in Fig. 1, the perigynia of *Carex herteri* appear to be oversized for the diminutive stature of the plant. Indeed, the combination of large perigynia with few of them per spike, large achenes that are strongly apiculate, and leaves with ciliate margins, readily separates this species from all other Uruguayan carices. It appears to be most closely related to

members of the *C. phalaroides* species complex (sect. *Digitatae* (Fries) Christ subsect. *Radicales* Kük., sensu Kükenthal 1909), a group of mostly South American carices characterized by having androgynous spikes, cuspidate scales, and sharply trigonous achenes. Although the aspect of *C. berterii* and *C. phalaroides* is strikingly similar, they differ in several features. For example, the former differs from the latter by having: ciliate leaf margins; fewer perigynia per spike; much larger perigynia that are glabrous and distinctly beaked; larger achenes that are strongly apiculate; and differently-shaped scales. Also see Table 1.

Notably, numerous sheets of *Carex phalaroides* have been examined from eastern Argentina, southern Brazil, southeastern Paraguay, and Uruguay, but thus far only the holotype of *C. berterii* is known. It seems remarkable that a species with such large and distinctive perigynia as *C. berterii* has hitherto been overlooked. However, the diminutive stature of both *C. berterii* and *C. phalaroides*, and their physiognomic similarity to each other, undoubtedly has contributed to the former species having been overlooked in the past. Another factor may be the early fruiting date of this species. The plants are known to bear ripe achenes in early October, indicating that the species probably flowers in late July and August. Also, though as yet unverified, *C. berterii* may be a local endemic with only a few existing populations.

A NEW NAME IN SOUTH AMERICAN CAREX

Carex gibertii G. A. Wheeler, nom. et stat. nov. BASIONYM: *Carex phalaroides* Kunth var. *crassiflora* Kük., Verh. Bot. Ver. Brandenburg 47:209. 1905. TYPE: URUGUAY. [DEPART. MONTEVIDEO:] Montevideo, [Cerro de Montevideo, in saxosis, 4 Oct 1864,] *Gibert* 593 (LECTOTYPE, here designated: S!; ISOLECTOTYPE: MVM?). Because the holotype at Berlin (B) was destroyed, the isotype at S, which was annotated by Georg Kükenthal (in 1904) as "*Carex phalaroides* Kunth var. *crassiflora* Kük. var. nov.," is chosen as lectotype.

Carex gibertii is an uncommonly collected species, thus far known from southern Brazil, Uruguay, and northeastern Argentina. Growing in dry sites, it flowers in late September and October and mature fruit has been collected from November through March. The epithet *crassiflora* is not available for use at species rank because of the earlier *C. crassiflora* Kük. Hence, I here offer the name *C. gibertii* for the species, after the Uruguayan botanist José Ernesto Gibert (1818–1886), who made the type collection. The plant has been illustrated in Chebataroff (1942, Lam. I, C–D).

Additional specimens examined: (*Carex gibertii*): ARGENTINA. Prov. Buenos Aires: Vela, 10 Mar 1910, *Stuckert* 21543 (LIL). BRAZIL. State of Rio Grande do Sul: Pelotas, 9 Nov 1955, *Sacco* 404 (F). Uruguay. Depart. San José: Mauricio, barrancas, Nov 1940, *Chebataroff* 4016 (SI).

TABLE 1. A selected morphological comparison of *Carex gibertii*, *C. berterii*, and *C. phalaroides* in south-eastern South America.

Character	<i>Carex phalaroides</i>	<i>Carex gibertii</i>	<i>Carex berterii</i>
fertile culm height (cm)	2–21	7–13	ca. 2
leaf margins	smooth or sparingly ciliate	smooth or minutely serrulate (but sparingly so near apex)	ciliate
spike width (mm)	3–5.5(–6) (average 5)	6–10 (average 8)	4–5
number of perigynia per spike	(5–)10–40	(5–)8–35	3–4
perigynium length (mm)	2.6–3.2 (average 3)	3.2–4.6 (average 3.9)	4.4–4.8
perigynium width (mm)	1.1–1.5 (average 1.3)	1.6–2 (average 1.7)	2–2.3
perigynium vestiture	pubescent	pubescent	glabrous
perigynium beak length (mm)	beakless or nearly so	beakless or nearly so	0.8–1.2
pistillate scale average length (mm) (excluding awn)	3	4	4.5
achene length (mm)	1.5–1.9 (average 1.7)	2–2.8 (average 2.4)	3.3–3.5
achene width (mm)	0.9–1.2 (average 1.1)	1.5–1.9 (average 1.6)	1.8–2
achene apex and tip length (mm)	short apiculate, <0.2	short apiculate, <0.2	strongly apiculate, ca. 0.8
anther length (mm)	the majority <2.6	the majority >2.6	unknown

Like the new species described earlier, *Carex gibertii* is a member of the *C. phalaroides* species complex. Kükenthal (1905, 1909) and subsequent workers (Osten 1931, Chebataroff 1942) have called these plants *C. phalaroides* var. *crassiflora*, but there appears to be a real discontinuity in morphology between the two. Indeed, examination of type material, along with other specimens, reveals that the two entities are closely related yet taxonomically distinct species. *Carex gibertii* differs from *C. phalaroides* by having larger spikes, perigynia, achenes, and scales. In Table 1, I have calculated mean values of several characters for both species, and, in each case, the corresponding means are so disparate that two species are strongly suggested. For example, perigynium mean length and width in *C. gibertii* are 3.8 mm and 1.7 mm, respectively, whereas those in *C. phalaroides* are 3 mm

and 1.3 mm. Also, no intergrades between these two species have been seen. Moreover, the two apparently grow in different habitats. *Carex gibertii* has been collected "in saxosis" (rocky soil) and in "barrancas" (ravines), whereas *C. phalaroides* frequents moist meadows and grasslands, pastures, and roadside embankments.

Carex gibertii differs from *C. berteri* by having taller culms, leaves lacking marginal hairs, more perigynia per spike, smaller achenes and scales, and slightly smaller perigynia that are pubescent and shorter beaked. A morphological comparison of 13 characters for the three species discussed in this paper is given in Table 1.

ACKNOWLEDGMENTS

I want to thank the curators and directors of the following herbaria for the loan of specimens of the *Carex phalaroides* species complex: B, BAA, BAB, BM, C, F, G, GH, K, LIL, MICH, MIN, MO, NY, P, S, SGO, SI, UC, UPS, US, and WIS.

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NATURAL HYBRIDIZATION AMONG THREE SYMPATRIC *BAPTISIA* (FABACEAE) SPECIES IN NORTH CENTRAL TEXAS

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ABSTRACT

A north central Texas *Baptisia* (Fabaceae, Faboideae, Thermopsidae) hybrid complex containing three parents (*B. australis*, *B. sphaerocarpa*, and *B. bracteata*) and the three F₁ hybrids is investigated using morphological, spectrophotometric, and isozyme electrophoretic methods. Two of the three hybrids (*B. × bushii* and *B. × bicolor*) have been previously named, but the *B. australis* × *B. sphaerocarpa* hybrid (*B. × variicolor*) is here described for the first time. This is the first report of sympatric occurrence of these three *Baptisia* species and all the possible F₁ hybrids. Morphological evidence for introgressive hybridization involving *B. australis* and *B. sphaerocarpa* is presented.

RESUMEN

Un complejo de híbridos del norte de Texas, *Baptisia* (Fabaceae, Faboideae, Thermopsidae) que contiene tres padres (*B. australis*, *B. sphaerocarpa*, y *B. bracteata*) y tres híbridos F₁ se investiga por métodos morfológicos, espectrofotométricos, y de electroforesis de isozimas. Dos de los tres híbridos (*B. × bushii* y *B. × bicolor*) habían sido nombrados previamente, pero el híbrido de *B. australis* × *B. sphaerocarpa* (*B. × variicolor*) se describe aquí como nuevo. Esta es la primera cita de la existencia simpátrica de estas tres especies *Baptisia* y todos los híbridos posibles de F₁. Se presenta la evidencia morfológica de hibridación introgresiva que afecta *B. australis* y *B. sphaerocarpa*.

INTRODUCTION

The genus *Baptisia*, commonly called Wild Indigo, is a perennial, herbaceous, and conspicuously flowered legume genus with about 25–30 species occurring in the eastern United States. In Texas they occur in remnant native habitats and are common weeds in overgrazed pastures (Turner 1959).

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Taxonomic difficulties have been common in the group due to extensive hybridization and introgression among species (Correll & Johnston 1970). This taxonomic confusion and the proliferation of secondary compounds within the genus led to early use of chemical taxonomic methods (e.g. chromatography by Turner & Alston 1959; Alston & Turner 1962; Alston & Turner 1963), and later detailed investigation of flavonoid distributions within the genus (Markham et al. 1970; Dement & Mabry 1975). Because of this work, a great deal is known about *Baptisia* both morphologically and chemically.

Three *Baptisia* species occur in the area of north central Texas studied, *B. australis* (L.) R. Br. ex W.T. Aiton var. *minor* (Lehm.) Fern. (a blue-violet-flowered species, Fig. 1), *B. sphaerocarpa* Nutt. (a yellow-flowered species, Fig. 1), and *B. bracteata* Muhl. ex Ell. var. *leucophaea* (Nutt.) Kartesz & Gandhi (a cream-flowered species, Fig. 1). Nomenclature follows Kartesz (1994). *Baptisia australis* reaches the southern extreme of its range in the north central Texas area, *B. bracteata* reaches its western boundary in the area, and *B. sphaerocarpa* reaches its northern extreme in central Oklahoma (Larisey 1940a). The area where all three ranges overlap is limited to north central Texas, southern Oklahoma, and western Arkansas (Fig. 2).

Hybridization and multispecies hybrid complexes are well documented in the genus *Baptisia*, both through traditional morphological methods and through extensive chemical analysis. In her monograph on the genus *Baptisia*, Larisey (1940a) recognized eight *Baptisia* hybrids and cited the relatively frequent occurrence of hybridism, particularly in areas where the borders of the geographically larger species overlap. At several north central Texas locations in Grayson County and neighboring Fannin County, several *Baptisia* species coexist and have been suspected of hybridizing (Kosnik 1996). The *B. australis* $\times$ *B. bracteata* hybrid, with an intermediate or light blue-violet flower (Fig. 1), has been described previously (*B. $\times$ bicolor* Greenm. & Larisey), and the *B. bracteata* $\times$ *B. sphaerocarpa* hybrid, with an intermediate or light yellow flower (Fig. 1), has also been described previously (*B. $\times$ bushii* Small). However, the proposed *B. australis* $\times$ *B. sphaerocarpa* hybrid, with a flower color varying from brick-red and yellow to orangish to bluish-violet and yellow (Figs. 1 and 3), has not been previously described in the literature.

Baptisia bracteata, *B. australis*, and *B. sphaerocarpa* have also each independently been observed hybridizing with other members of the genus. *Baptisia australis* $\times$ *B. bracteata* hybrids have been observed in Kansas (Hitchcock 1894). *Baptisia sphaerocarpa* $\times$ *B. laevicaulis* hybrids have been described using morphological and chemical methods in southeastern Texas by Turner and Alston (1959) and Alston and Turner (1962). *Baptisia sphaerocarpa* $\times$ *B. leucantha* hybrids were observed in Oklahoma by Engelmann (1878),

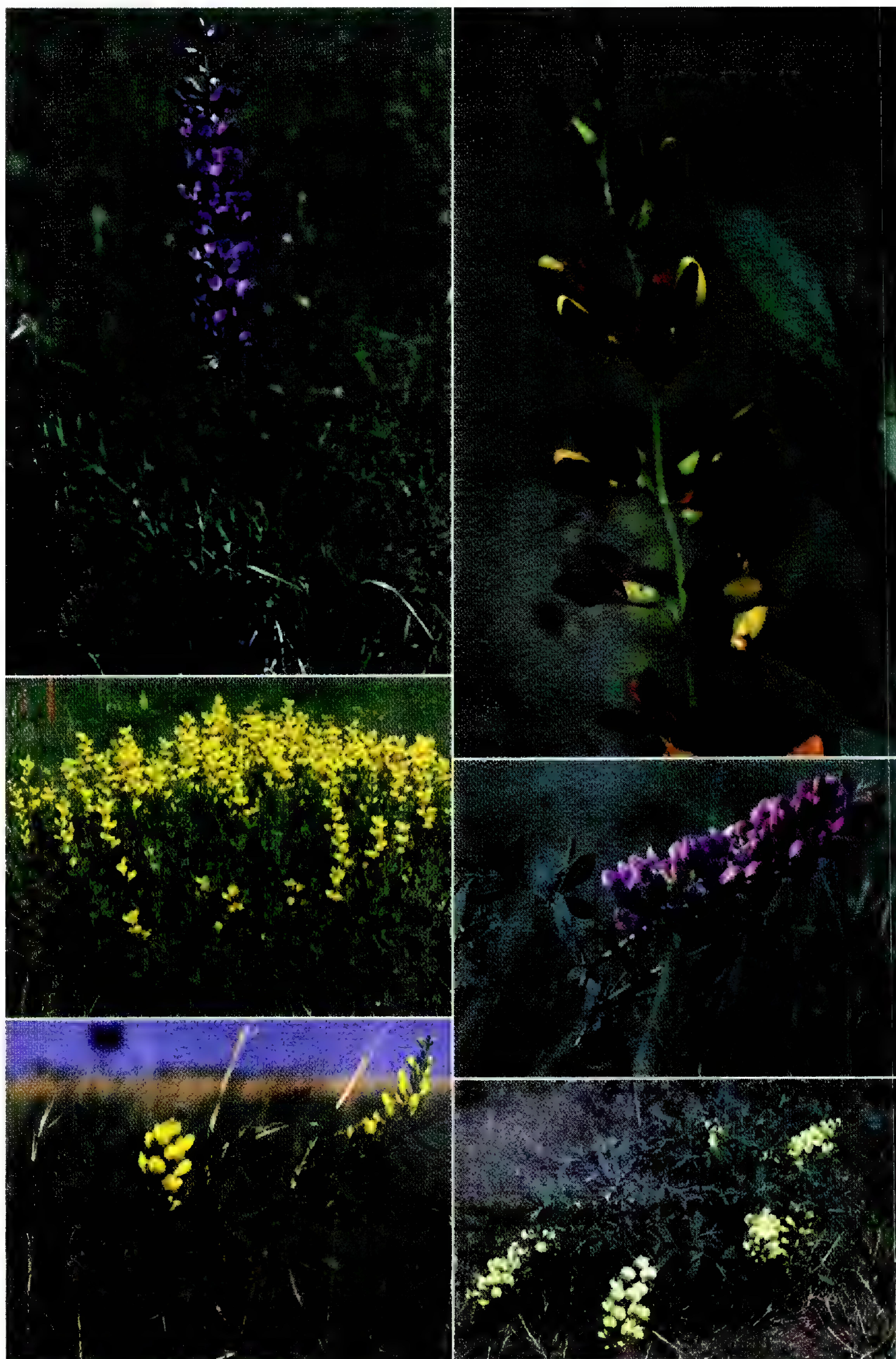


FIG. 1. Photographs of parental species and hybrids. Clockwise from upper left: *Baptisia australis*, *B. × variicolor*, *B. × bicolor*, *B. bracteata*, *B. × bushii*, and *B. sphaerocarpa*.

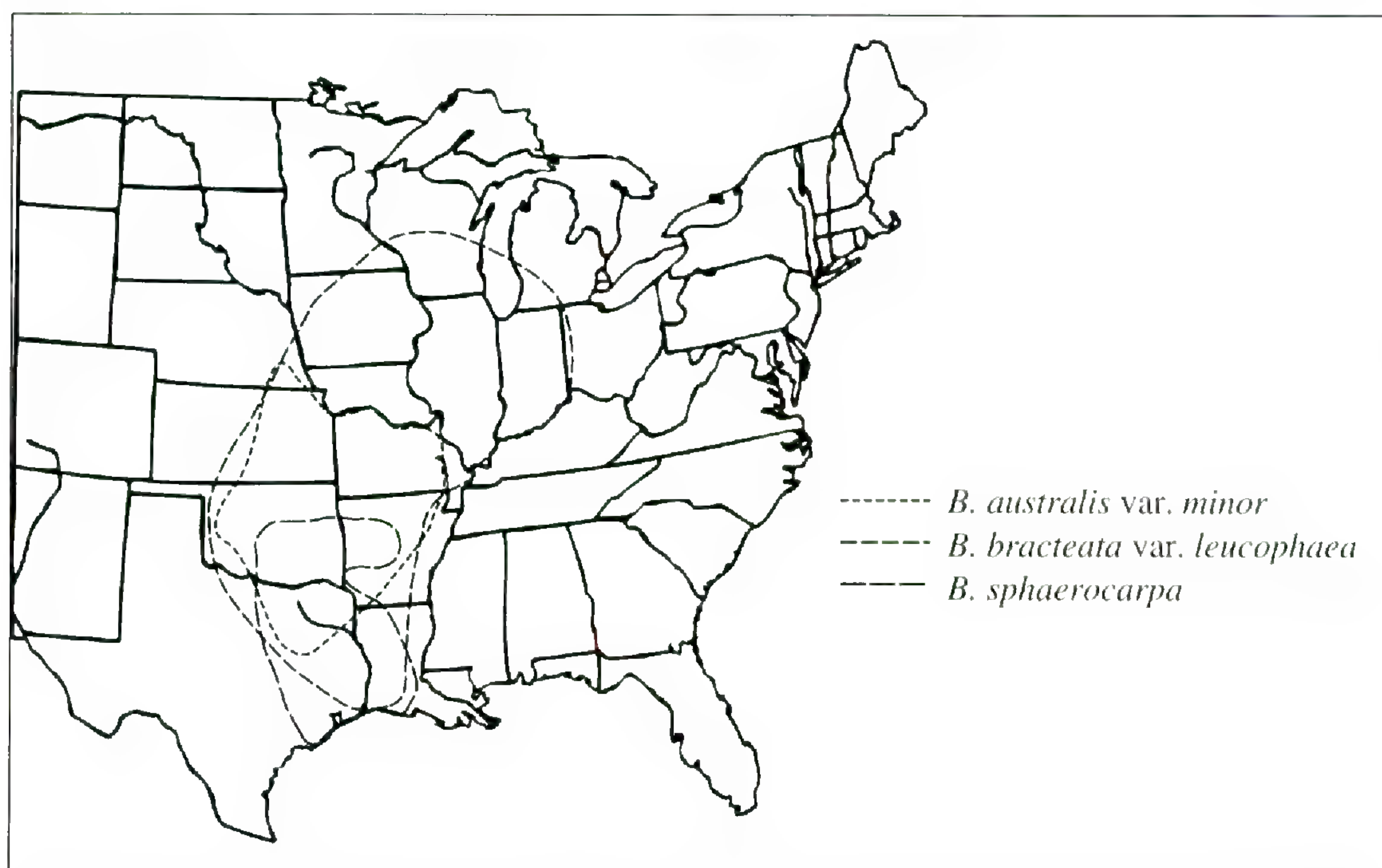


FIG. 2. Distribution map for the parental species. (Modified from Larisey 1940a).

and in southeastern Texas they were described morphologically by Larisey (1940b) and morphologically and chemically by Alston and Turner (1962). *Baptisia sphaerocarpa* $\times$ *B. bracteata* hybrids were observed in Louisiana by Harper (1938). However, it is only in north central Texas that all three of these species and all three possible F_1 hybrids have been observed in mixed populations. Introgressive hybridization (Anderson 1949), or the movement of genes from one species into another via fertile hybrids, has also been suggested for *Baptisia* (e.g., Alston & Turner 1963; Correll & Johnson 1970).

METHODS

Collection localities.—Plant material was collected at 11 sites in Grayson and Fannin counties, Texas. At three additional sites hybrids were observed but not collected. Table 1 summarizes collections and observations. Coordinates for each site (Table 1) were determined using a Garmin 45 Global Positioning System. Voucher specimens are deposited at the Botanical Research Institute of Texas (BRIT) in Fort Worth.

Morphological Measurements.—Measurements of a number of characters were made in the field, prior to collection and pressing. Vegetative height was measured from the ground to the highest leaves (0.5 cm increments). Plant height was measured from the ground to the maximum height (0.5 cm increments). Raceme angle was measured with a weighted protractor (2.5° increments, 0° considered vertical and 90 considered horizontal). Total flower length (from the base of the flower to the tip of the keel or wings), total

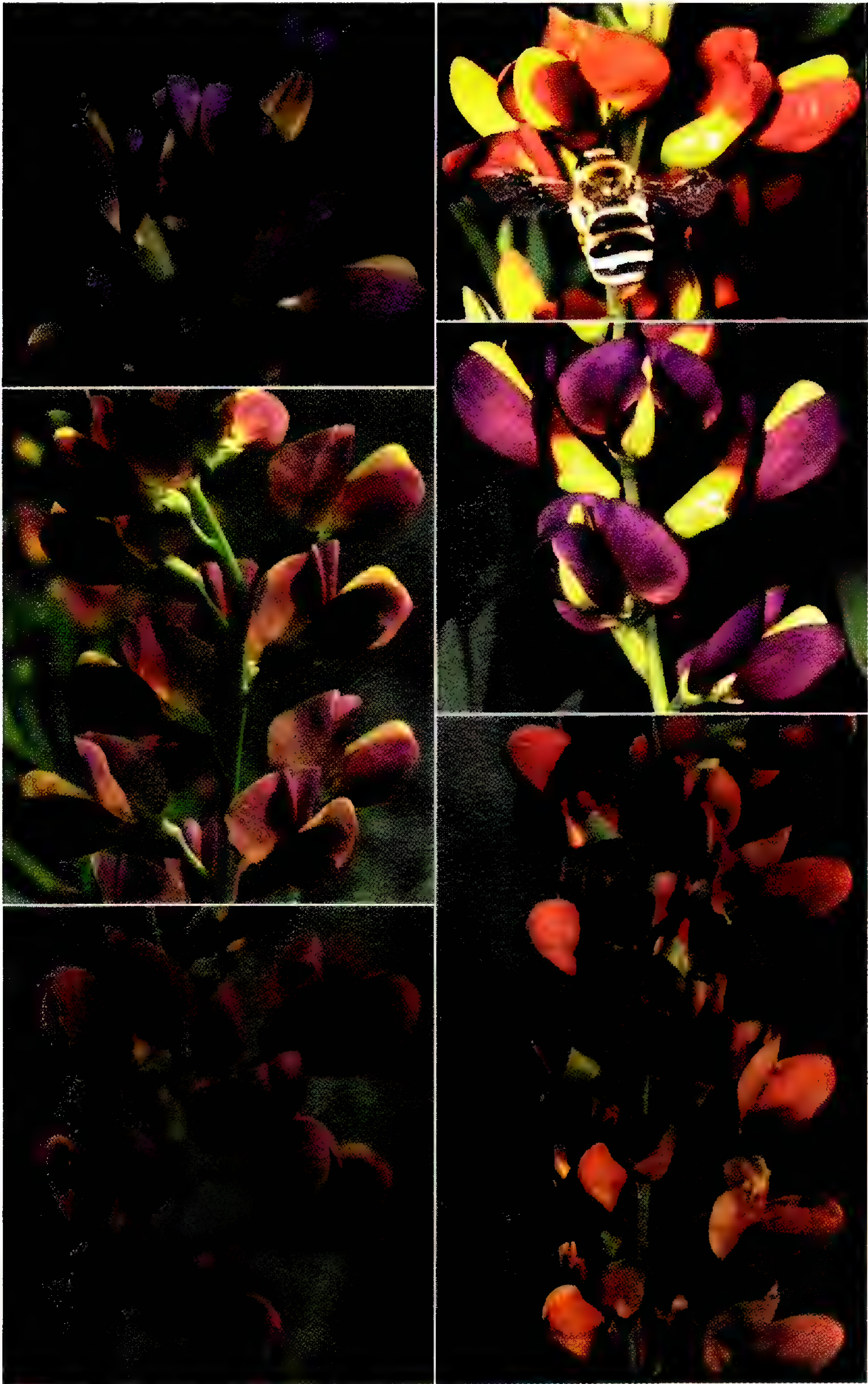


FIG. 3. Photographs of *B. × variicolor* (*B. australis* × *B. sphaerocarpa*). Note variable flower color.

TABLE 1. Sites and collections. Plants are indicated: B = *B. australis*, BY = *B. × variicolor*, Y = *B. sphaerocarpa*, YC = *B. × bushii* (*sphaerocarpa* × *bracteata*), C = *B. bracteata*, CB = *B. × bicolor* (*bracteata* × *australis*). Collection number indicates the number of herbarium specimens collected at each location, an X indicates that the plant was observed but not collected for pressing.

Location Name	Position		Collection/Observation					
	Latitude	Longitude	B	BY	Y	YC	C	CB
FAN-A6	33° 31'	96° 20'	3	5	10	4	10	7
G36-CY	33° 44'	96° 49'			10	3	10	
GEO-B	33° 36'	96° 31'	10					
HAG-C	33° 45'	96° 48'					5	
MEM-CY	33° 46'	96° 38'			5	5	5	
PRE-A6	33° 48'	96° 38'	6	2	X	2	2	7
PRE-BY	33° 47'	96° 36'	7	1	2			
HAG-Y	33° 45'	96° 48'			10			
1417-Y	33° 41'	96° 39'			5			
PWR-B	33° 31'	96° 28'	10					
POT-A6	33° 47'	96° 38'	X					1
ORIGIN	33° 32'	96° 22'		X	X			
B36-CY	33° 44'	96° 48'			X	X	X	
FAN-CY	33° 31'	96° 20'			X	X	X	
Total			36	8	42	14	32	15

flower height (from the bottom of the keel or wings to the tip of the banner), maximum horizontal width of the wings, and maximum banner width were measured with digital calipers (0.01 mm increments). All flower measurements were made on the lowest fully developed, intact flower on the best developed inflorescence, with at least one fully developed flower above it.

Measurements of all other vegetative characters were made after pressing using digital calipers (0.01 mm increments). These included pedicel length (of the measured flower); floral bract length, maximum width, width at attachment; petiole length; central leaflet length, maximum width, distance to the maximum width (from the leaflet base); and stipule length, maximum width, width at attachment, and distance to maximum width (from the stipule base). The leaflet measurements were taken on the center leaflet of the first undamaged, well developed leaf below the raceme. Stipule measurements were taken from the same leaf, unless the leaf did not have a stipule, in which case the stipule closest to that leaf was measured (this was often the case with *B. sphaerocarpa*).

Fruit characters were chosen to examine for evidence of introgressive

hybridization between *B. australis* and *B. sphaerocarpa* because of the very different fruit shapes and sizes of these taxa and thus the increased probability of finding unambiguous evidence of introgression. Individuals from the hybrid population were labeled as to flower color during the spring flowering season and fruits were subsequently collected when mature. Fruit measurements were taken using digital calipers (0.01 mm increments) from completely dried fruits collected in the field in June and July from FAN-A6, GEO-B, HAG-Y, and PWR-B (Table 1). These included maximum fruit length (not counting stipe or beak), height, width, and length of beak (from where fruit body narrows dramatically apically to tip of beak). Measurements were taken on the lowest well developed, well preserved fruit on an infructescence.

The Royal Horticultural Society Colour Chart (1966) was also used in an attempt to standardize color measurements. The lowest, mature, undamaged flower on the raceme was color matched before it dried.

Statistical Analyses.—Morphological measurements were analyzed using principal component analysis, multiple discriminant analysis (a multivariate statistical technique sometimes called canonical analysis), and analysis of variance and run with Minitab 10.5Xtra (1995) and BioStat II (Pimentel 1995) on a Macintosh Centris 650. Because missing data are not allowed in these analyses, only the characters listed in Tables 2 and 3 were used. Principal component analysis attempts to unravel patterns of variation within the entire dataset, while multiple discriminant analysis attempts to minimize within group variation while maximizing between group variation. Discriminant analysis computes synthetic characters by weighting dataset characters to maximally separate the groups. For the discriminant analysis individuals were assigned to one of six groups based on flower color.

Spectrophotometric Analysis.—Flowers from four to nine individuals of each of the six taxa were examined spectrophotometrically. Flowers from three sites (FAN-A6, MEM-CY, and PRE-A6) were selected to represent the maximum variation seen within the populations. Petals from a fresh, undamaged, mature flower were ground completely in 2 ml of a 1:4, 1% HCl: 100% EtOH solution; the samples were then centrifuged for three minutes to separate large particulate material. One ml of the resulting extract was diluted with an additional 2.5 ml of solvent. An ultraviolet-visible light absorbance spectrum was then measured using a Beckman DU-70 scanning spectrophotometer; absorbance scans were run at 1200 nm/min. from 200 nm to 700 nm. Absorbances for peaks at 422 nm, 449 nm, and 540 nm (± 2 nm) were recorded.

Enzyme Electrophoretic Analysis.—Leaf samples were obtained from 21 individuals including *B. australis*, *B. sphaerocarpa*, and all three F₁ hybrids at FAN-A6 in July 1990. *Baptisia bracteata* was not examined. Starch gel

enzyme electrophoretic procedures generally followed Soltis et al. (1983). The tris-HCl grinding buffer-PVP solution described by Soltis et al. (1983) was used with a PVP 40,000 concentration of 12% (wt/vol). Starch gel concentration was 12.5%.

The following enzymes were resolved: aspartate aminotransferase (AAT or GOT), glyceraldehyde 3-phosphate dehydrogenase (G3PDH), isocitrate dehydrogenase (IDH), malate dehydrogenase (MDH), 6-phosphogluconate dehydrogenase (6PGD), shikimate dehydrogenase (SKDH), and triosephosphate isomerase (TPI). Buffer systems follow Soltis et al. (1983): G3PDH and SKDH were resolved on a modification of gel and electrode buffer 1; GOT and TPI on a modification of buffer 8 (modification described by Soltis & Soltis 1987); 6PGD on a modification of buffer 9; and MDH and IDH on a morpholine system (electrode buffer: 0.04 M citric acid, pH 7.5 by addition of N-(3-aminopropyl)-morpholine; gel buffer: dilute electrode buffer 1:25). Staining procedures followed Soltis et al. (1983).

RESULTS

Morphological Analysis.—Based simply on flower color, the three parents and their intermediate putative hybrids are easily distinguished. A variety of morphological characters also suggest hybridization. Simple two character plots of raceme angle versus flower size (height) or leaflet size (length) distinguish six basic morphological groups which support the hybridization hypothesis (Fig. 4). The three hybrids are generally intermediate morphologically between the parents. These graphs also show considerable overlap among hybrid taxa.

Principal component analysis separates the taxa in a manner similar to the two character plots. The plot of the first principal component versus the second principal component illustrates that variation within all six taxa (3 parental species and 3 hybrids) is less than the variation between taxa (Fig. 5)—in other words, groups can be observed though there is some overlap. Individuals of the three parental species form discernable clusters toward the periphery of the plot, while all the suspected hybrid taxa are generally intermediate between the purported parental species. Character weightings are given in Table 2.

Discriminant analysis separates the taxa with greater resolution than the principal component analysis, but still does not completely separate all individuals of all the taxa (Fig. 6). The discriminant analysis supports 94% of the original flower color grouping. The 6% of the individuals which are ambiguously grouped by the discriminant analysis on the basis of the morphological data are clearly distinct in other characters, such as flower color. The linear discriminant functions are given in Table 3.

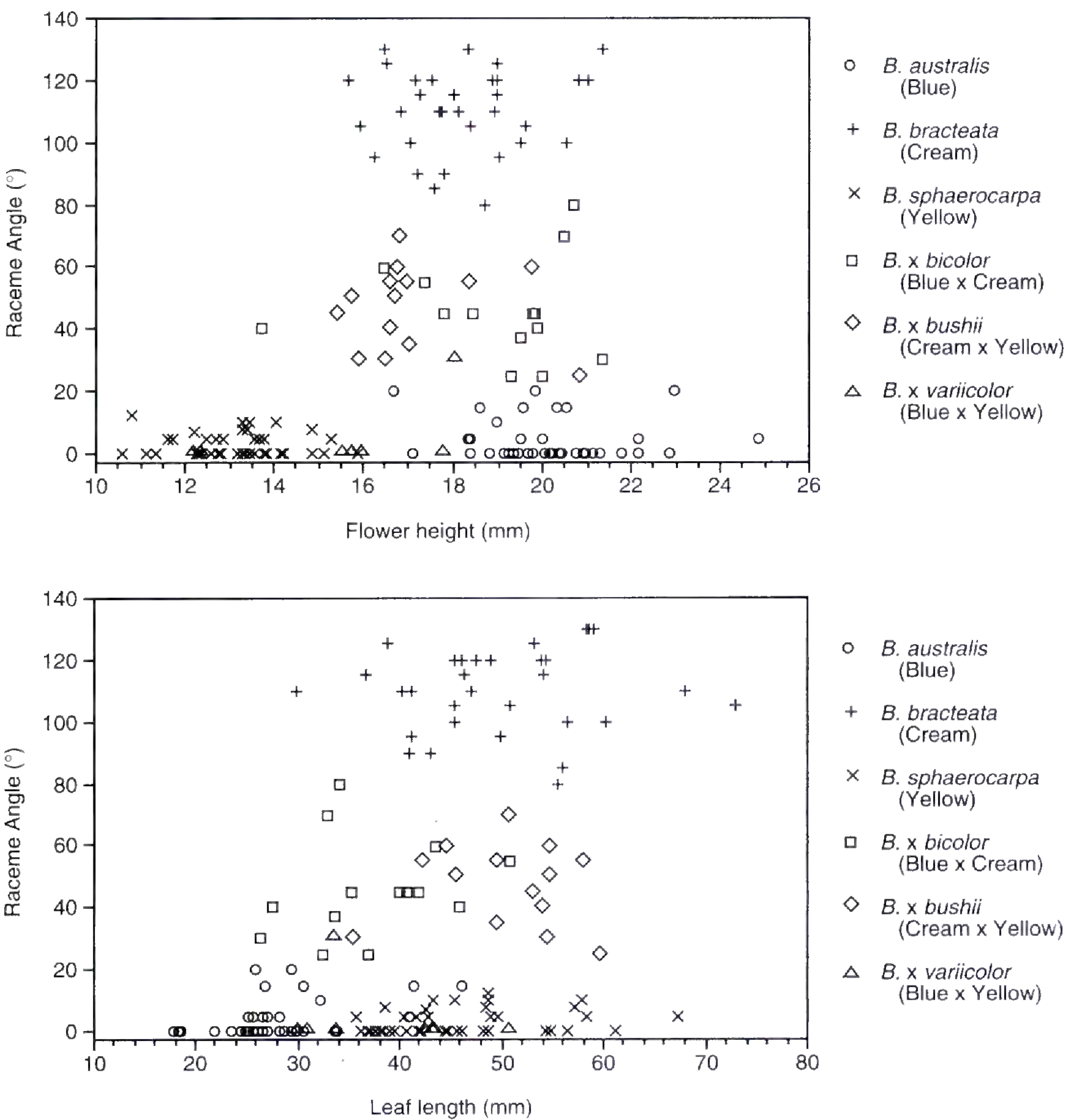


FIG. 4. Two character plots of raceme angle versus flower height and leaf length.

There are additional characters, suggestive of hybridization, that were not included in the principal component analysis or the discriminate analysis because they could not be accurately and consistently quantified. These include hairs (too numerous to count effectively on *B. bracteata*), flower bracts (length, maximum width, and distance to maximum width cannot be measured on plants without persistent bracts), and flower color (not continuously quantifiable). *Baptisia bracteata* is densely pubescent, has large persistent floral bracts (10–30 mm long), and cream flowers, while *B. sphaerocarpa* and *B. australis* are glabrous, have smaller, early deciduous bracts (0–5 mm long), and have vividly colored flowers (bright yellow in the case of *B. sphaerocarpa* or blue-violet in the case of *B. australis*). The hybrids, *B. x bushii* (*B. sphaerocarpa* × *B. bracteata*) and *B. x bicolor* (*B. australis* × *B. bracteata*) show intermediate values for these characters.

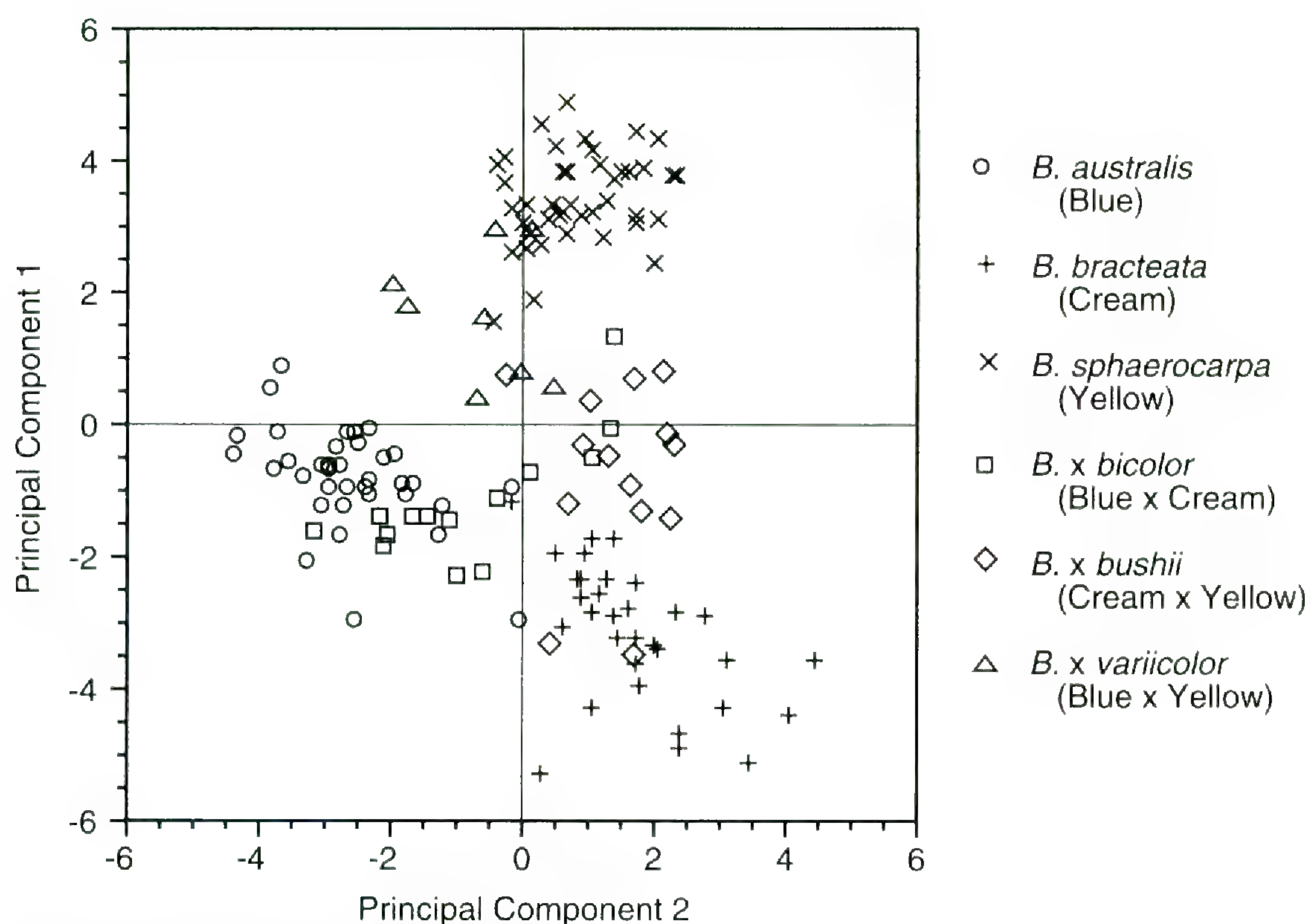


FIG. 5. Principal components analysis.

bracteata), are intermediate between their respective parents in all of these characters. *Baptisia sphaerocarpa* and *B. australis* are easily distinguished by flower color and plant form. *Baptisia sphaerocarpa* has numerous flexible, vegetative branches creating a bushy form, commonly multiple racemes per plant, and intense yellow flowers. *Baptisia australis* has fewer, much more rigid branches, typically only one raceme per plant, and a blue-violet flower color that varies greatly in saturation between plants. *Baptisia variicolor* is generally vegetatively intermediate, but often is superficially more similar to *B. sphaerocarpa*; they have vegetative branches creating a bushy form and often have multiple racemes per plant. The flower color of *B. x variicolor* is strikingly variable. It ranges from intermediate to a patch-work combination of the parental flower colors, with different hybrid individuals having flowers ranging from brick-red and yellow to orangish to bluish-violet and yellow. This variation can be seen in Figs. 1 and 3. The Royal Horticultural Society Colour Chart measurements are an indication of the variation in color (Table 4).

Spectrophotometric Analysis.—The absorbance spectra indicate three diagnostic wavelengths (Fig. 7). *Baptisia australis* has a large peak at 540 nm, *B. sphaerocarpa* has distinct peaks at 422 nm and 449 nm, and *B. bracteata* has low absorbance at all of the diagnostic wavelengths. *Baptisia variicolor* clearly shows both parental peaks, while *B. x bicolor* and *B. x bushii* have peak

TABLE 2. Principal component character weightings.

Variable	Component 1	Component 2
Plant total height	0.272	-0.205
Plant vegetative height	0.275	-0.063
Raceme angle	-0.276	0.264
Flower total length	-0.236	-0.326
Flower max. wing width	-0.036	0.123
Flower total height	-0.291	-0.265
Flower max. banner width	-0.257	-0.300
Petiole length	-0.284	0.184
Pedicle length	0.108	-0.046
Leaflet length	-0.002	0.479
Leaflet max. width	0.198	0.344
Leaflet distance to max. width	-0.042	0.438
Stipule length	-0.332	0.114
Stipule max. width	-0.346	0.096
Stipule width at attachment	-0.348	0.045
Stipule distance to max. width	-0.288	-0.050

absorbances intermediate between those of the parental species (Fig. 7). Absorbance data for the diagnostic wavelengths are given in Table 5.

Electrophoretic observations.—Preliminary electrophoretic observations on *B. australis*, *B. sphaerocarpa*, and the three F₁ hybrids show low levels of variation both within and between taxa. Eight of ten loci, *Aat*, *Idh*, *G3pdh*, *Mdh-1*, *Mdh-3*, *6Pgd*, *Skdh*, and *TPI-2*, were monomorphic with all individuals of all taxa expressing exactly the same alleles (one individual of *B. australis* did not express the *Mdh-1* allele). For *Mdh-2* all individuals were monomorphic for the *Mdh-2b* allele except one individual of *B. australis* and one individual *B. × bicolor* which also expressed *Mdh-2a*. For *Tpi-1* all individuals expressed *Tpi-1b* with most individuals being homozygous. However, one *B. × bushii* individual and one *B. × bicolor* individual were heterozygous *Tpi-1a* and *Tpi-1b*, while five *B. australis* individuals and two *B. × bicolor* individuals were heterozygous *Tpi-1b* and *Tpi-1c*.

General observations.—It is important to note that the spring flowering times of these species overlap by several weeks. *Baptisia bracteata* flowers first, followed by *B. australis* and *B. sphaerocarpa*, which flower at roughly the same time with some variation depending on the particular site. A significant number of *B. bracteata* individuals are still flowering when *B. australis* and *B. sphaerocarpa* come into flower. *Baptisia sphaerocarpa* tends to

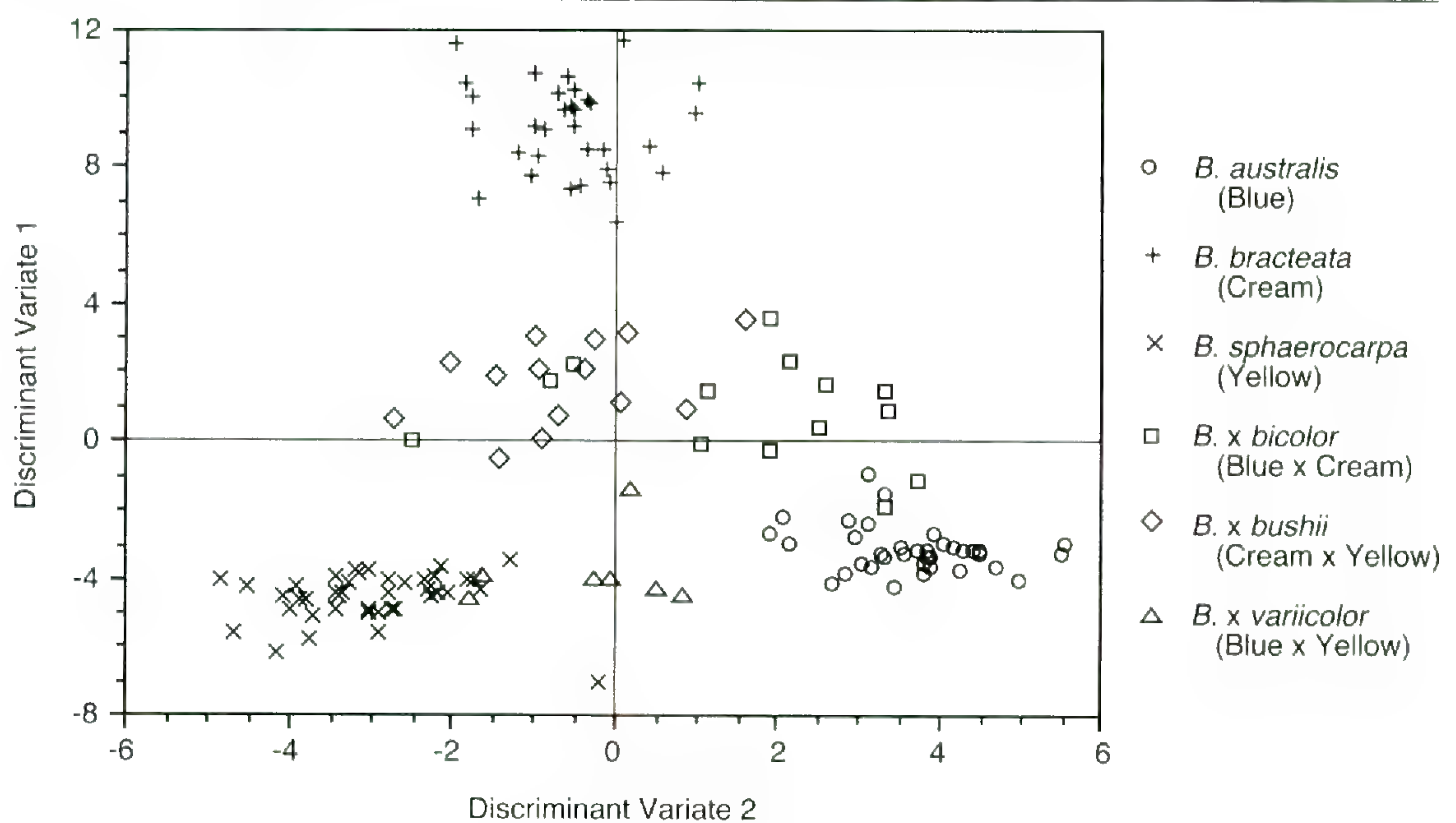


FIG. 6. Discriminant analysis.

flower somewhat longer, generally being the last of the species for which flowers can be observed. Hybrid flowering times in general are intermediate between those of the parent species. Over the course of field work during the 1996 flowering season, not only were the parental species simultaneously flowering, but also large bumble bees were observed indiscriminately visiting all three of the parents and hybrids (Fig. 3).

While several dozen hybrid individuals were observed, the number of individuals of the parental species are estimated in the hundreds or thousands. *Baptisia sphaerocarpa* in particular is quite abundant, being a vegetational dominant in overgrazed pastures. This species, which is apparently inedible to livestock, can have thousands of individuals in a single large field. At the sites containing more than one parental species, the expected hybrid(s) were always found, and the hybrids were always in much lower abundance than the parents. At the Fannin County site (FAN-A6) containing all six taxa, *B. australis* is fairly rare, while *B. sphaerocarpa* is the most common. *Baptisia variicolor* and *B. × bushii* are the two most common hybrids at that site. At the Grayson County site (PRE-A6) containing all six taxa, *B. sphaerocarpa* is rare, while *B. australis* is the most common. *Baptisia bicolor* and *B. × variicolor* are the more common hybrids at that site.

Soils differ significantly among sites; in the area studied, *B. australis* grows on Blackland clay soils, while *B. bracteata* and *B. sphaerocarpa* grow on sandy substrates. The hybrids involving *B. australis* occur either in the Preston Anticline in northern Grayson County where the soil types change rapidly allowing parental coexistence, or in western Fannin County in areas

TABLE 3. Linear discriminant functions.

Variable	<i>australis</i>	<i>bracteata</i>	<i>sphaerocarpa</i>	$\times$ <i>bushii</i>	$\times$ <i>bicolor</i>	$\times$ <i>variicolor</i>
Constant	-172.04	-202.93	-137.77	-155.08	-169.55	-141.85
Plant total height	0.30	0.04	0.02	-0.13	-0.01	-0.01
Plant veg. height	0.09	0.32	0.67	0.47	0.43	0.61
Raceme angle	-0.06	1.06	-0.09	0.36	0.37	-0.10
Flower length	4.10	3.05	3.61	3.24	3.95	3.65
Flower wing width	-0.58	0.30	0.62	0.24	-0.42	-0.10
Flower height	4.41	4.55	2.58	4.42	4.09	3.01
Flower banner width	3.74	2.31	2.85	2.87	3.56	3.52
Petiole length	-0.83	0.07	-0.86	-0.51	-0.79	-0.71
Pedicel length	-0.09	-3.38	0.01	-1.70	-0.61	0.11
Leaflet length	0.29	0.67	0.59	0.72	0.30	0.44
Leaflet width	1.88	1.03	2.06	1.71	1.74	1.89
L dist. to max. width	0.38	0.42	0.47	0.44	0.65	0.46
Stipule length	-1.40	-0.57	-1.39	-1.24	-1.44	-1.39
Stipule max. width	-0.50	0.90	-0.80	-0.89	-0.21	-1.13
S attachment width	4.88	5.85	2.88	6.77	6.11	4.53
S dist. to max. width	0.26	-4.69	-0.87	-1.71	-1.41	-0.07

of intermediate or mixed (a term used locally by early settlers) soil; plant communities closely parallel the geology of the area. *Baptisia bicolor* is known from only two sites within the study area, while the *B. australis* $\times$ *B. sphaerocarpa* hybrid is known from three sites in the study area, but has also been reported from southern Oklahoma (Shirley Lusk, pers. comm.). Both *B. sphaerocarpa* and *B. bracteata* grow on sandy soils, and the plant distributions observed in the field suggest that the habitat separation between these two species is subtle. The hybrid of these two parental species (*B.* $\times$ *bushii*) is by far the most common hybrid in terms of both number of individuals and number of sites at which they occur, which is to be expected since the parental species coexist more readily. The *B.* $\times$ *bushii* sites range from grazed pastures (G36-CY and B36-CY) to native prairie (MEM-CY).

Evidence for introgressive hybridization.—Figure 8 shows that fruit lengths and widths of the two monospecific populations of *Baptisia australis* (GEO-B and PWR-B) were different from those of individuals of the same species from a site with *B. sphaerocarpa* and known hybrids (FAN-A6). Measurements of fruit length and width of *B. australis* from the hybrid site were intermediate between those of *B. australis* and *B. sphaerocarpa* (HAG-Y) from sites with only a single species. In contrast, fruits of *B. sphaerocarpa*

TABLE 4. Royal Horticultural Society Color comparisons.

Plant species	Color matches
<i>B. australis</i>	91A, 91B, 92A, 92C, 93A, 93B, 94A, 94B, 95A, 102A
<i>B. × variicolor</i>	61A, 17A, 91A, 92A, 92C, 94A, 94B, 9A, 14A
<i>B. sphaerocarpa</i>	9A
<i>B. × bushii</i>	9A, 9B, 14A, 14B
<i>B. bracteata</i>	10C, 10D
<i>B. × bicolor</i>	90A, 90B, 92A, 93A, 94A,

TABLE 5. Absorbance at diagnostic wavelengths.

Plant Type	Sample Size	422 nm		449 nm		540 nm	
		Ave	St. Err	Ave	St. Err	Ave	St. Err
<i>B. australis</i>	6	.18	.02	.20	.03	.85	.16
<i>B. × variicolor</i>	9	.45	.05	.43	.05	.88	.08
<i>B. sphaerocarpa</i>	6	.78	.05	.65	.04	.05	.01
<i>B. × bushii</i>	5	.37	.06	.33	.04	.03	.01
<i>B. bracteata</i>	6	.18	.03	.15	.02	.03	.01
<i>B. × bicolor</i>	4	.17	.02	.16	.02	.44	.10

from the hybrid site (FAN-A6) showed almost complete overlap in size with fruits of *B. sphaerocarpa* from a monospecific site (HAG-Y). These differences were confirmed by one-way analyses of variance that tested for differences in fruit length and fruit width as a function of group (the four groups: *B. australis* from monospecific sites, *B. australis* from hybrid site, *B. sphaerocarpa* from monospecific site, *B. sphaerocarpa* from hybrid site). Multiple comparisons tests (Fisher's) showed that there were no significant differences between the *B. sphaerocarpa* populations from the monospecific and hybrid sites, but all other pairwise comparisons were significantly different.

DISCUSSION

Two character plots, principal component analysis, and discriminant analysis all point to a conclusion similar to the one intuitively derived when these plants are observed in the field—that is, some plants are hybrids intermediate between the respective parental species. Principal component analysis also shows that within taxon morphological variation is less than between group variation. Based on raceme angle and flower color it is possible that backcrosses between F₁ hybrids and parental species (*B. × bushii* crossed with *B. bracteata* and *B. × bicolor* crossed with *B. australis*)

occur, possibly resulting in introgressive hybridization. At the Grayson County site containing all six species, several individuals are suggestive of this possibility. Two unusual *B. bracteata* individuals with racemes at a 45 degree angle to the ground were observed, as well as some *B. australis* individuals with multiple racemes and an atypically flexible stem structure.

A *B. australis* population (from a site also containing *B. sphaerocarpa* and known hybrids) with fruit length and width values intermediate between typical *B. australis* and *B. sphaerocarpa* is suggestive of introgression (Fig. 8). Evidence from additional characters, including genetic markers, is needed to confirm this hypothesis. In contrast, the lack of fruit differences between *B. sphaerocarpa* from the hybrid and monospecific sites suggests that genes from *B. astralis* are not moving into *B. sphaerocarpa*.

Discriminant analysis separates the groups well, but some individuals are ambiguously placed. Plants were originally grouped to taxon based on flower color. The discriminate analysis concluded that 6% of the individuals were not originally placed in the proper group (obvious stray points in Fig. 8). These plants may be backcrosses of F₁ hybrids parental species, products of introgression, or abnormal individuals. However, the fact that 94% of the individuals are correctly classified, the intermediate placement on the plot of the hybrids relative to the parents, and the intermediacy in non-quantitative characters (e.g. pubescence and bract morphology) leaves little doubt that this is a hybrid system.

Spectrophotometric data also support what the eye observes (Fig. 7). Pigment levels in both hybrids involving *B. bracteata* (*B. × bushii* and *B. × bicolor*) are intermediate (an average of the two parents) and in *B. × variicolor* flower color is additive (a sum of the two parents). The extensive flower color variation seen in *B. × variicolor* reflects to a certain extent the variation seen in *B. australis*, but clearly exceeds that level of variation. In some cases the keel is only yellow, while the banner is a deep brick-red or bluish-violet, while in other cases the flower is uniformly orangish or blue-violet-yellow. It is important to note that despite this dramatic variation in observable color, all *B. × variicolor* flowers exhibit nearly identical absorbance spectra (all have the same peaks with only minor differences in the actual absorbance). *Baptisia australis* also has variable flower pigmentation; in some flowers the keel is almost white, while the banner is a variable blue-violet, while in others the whole flower is a variable blue-violet. This variation in color saturation is also observed in the variable absorbance at the 540 nm peak. *Baptisia bracteata* and *B. sphaerocarpa* show little variation in flower coloration.

The spectral data suggest that compounds from both parents might be found in the hybrids and that the north central *Baptisia* hybrid swarm may be an excellent candidate for detailed chemotaxonomic investigation. In

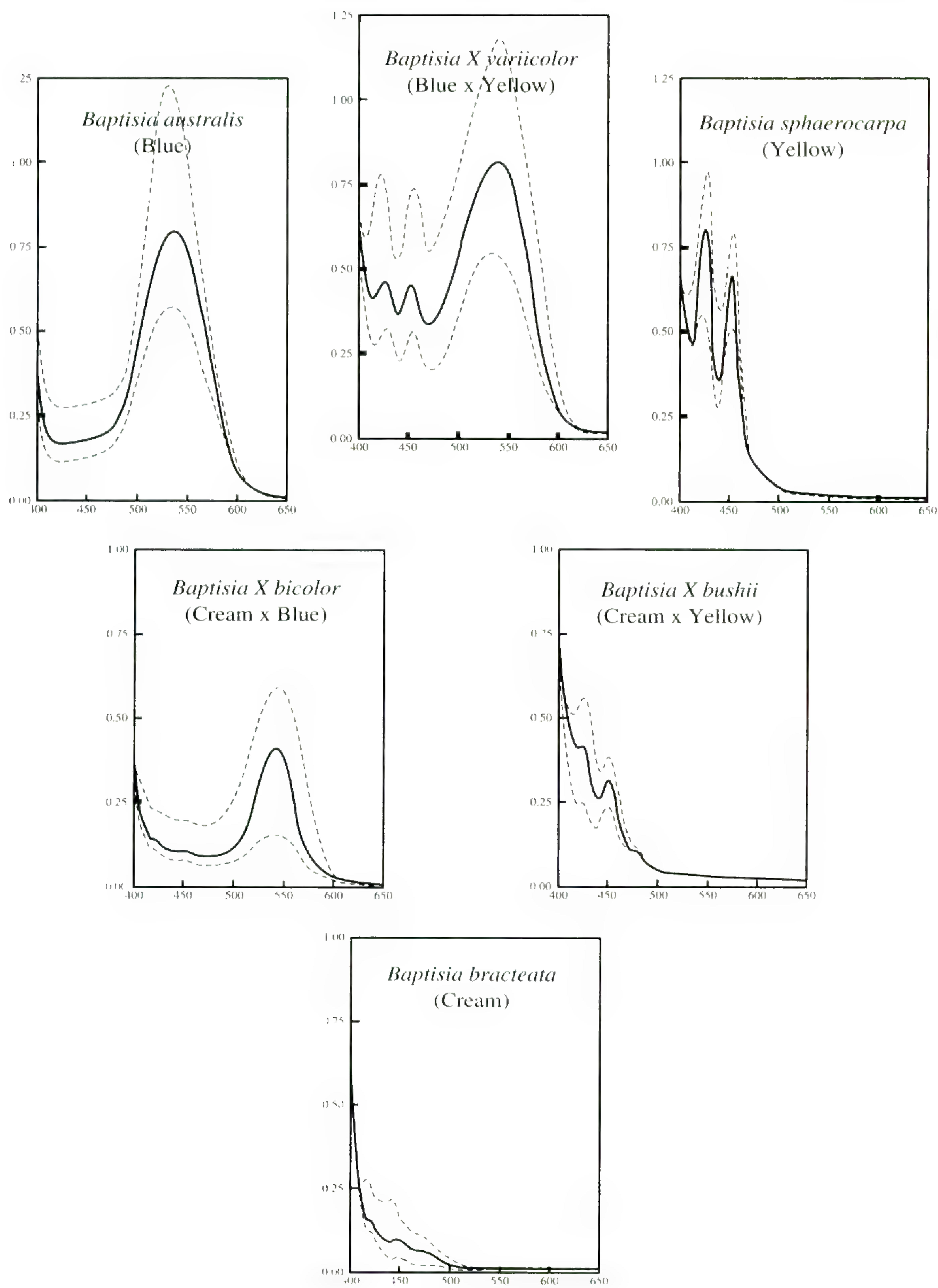


FIG. 7. Absorbance spectrum of flower extracts. Absorbance on the Y axis, wavelength (nm) on the X axis. Solid lines are mean absorbances (Table 5), dashed lines are the minimum and maximum absorbance spectra obtained.

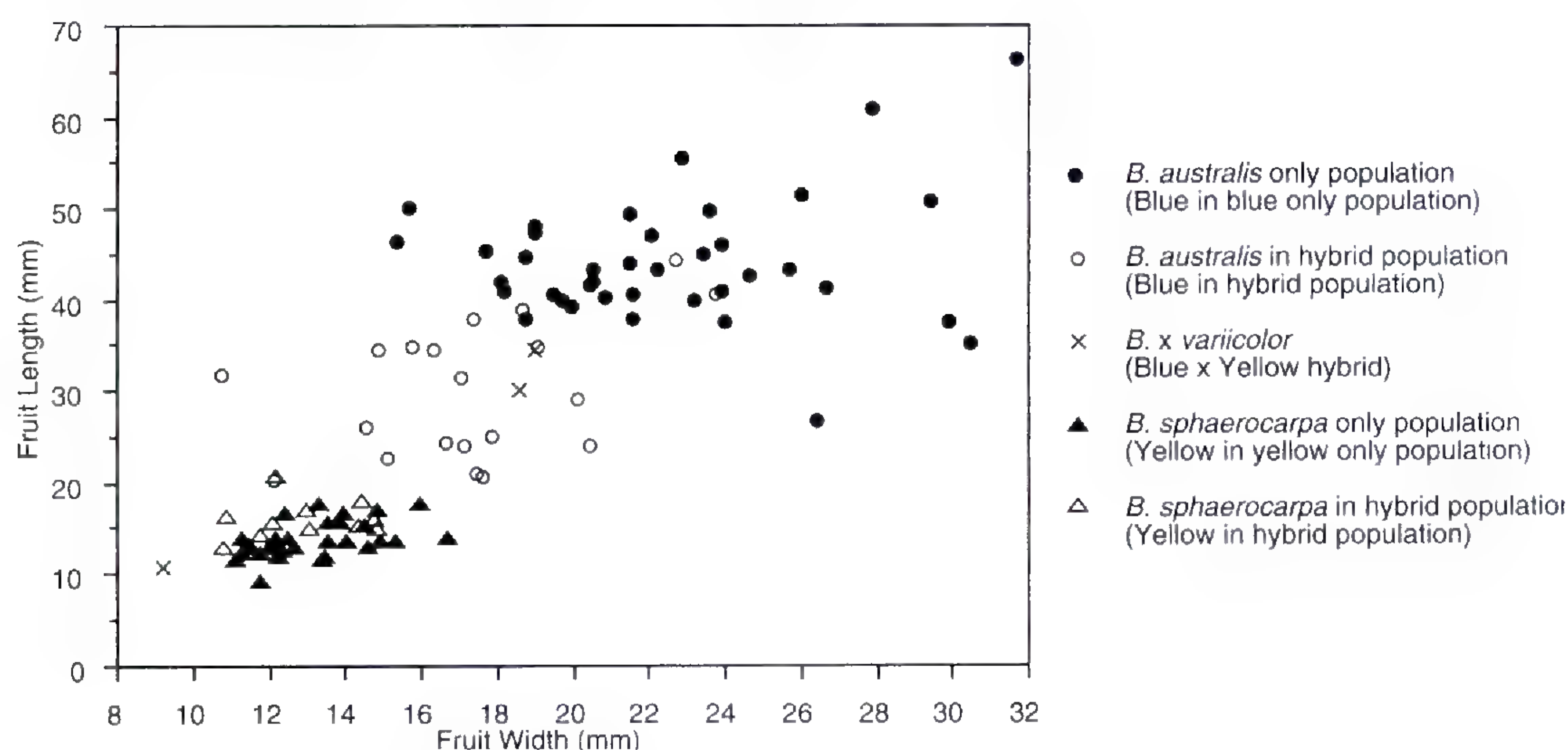


FIG. 8. Scatter diagram of fruit length and fruit width for *B. australis* from monospecific sites, *B. australis* from sites with *B. sphaerocarpa* and known hybrids, *B. variicolor*, *B. sphaerocarpa* from monospecific sites, *B. sphaerocarpa* from sites with *B. australis* and known hybrids. Blue-flowered individuals (*B. australis*) from the hybrid population are intermediate in fruit shape between *B. sphaerocarpa* and *B. australis* from sites with only a single species; this is suggestive of introgression.

their detailed study of *Baptisia* flavonoid chemistry, Markham et al. (1970), and later Dement and Mabry (1975), divide *Baptisia* into subgroupings based on the distribution of flavonoid pigments throughout the genus, placing *B. sphaerocarpa* and *B. australis* in separate subgroups within the genus because of large (relative to other members of the genus) chemical differences. In contrast to this, our preliminary electrophoretic data (eight of 10 loci monomorphic and identical) point to a close relationship between *B. sphaerocarpa* and *B. australis*. This similarity is consistent with the apparent ease with which hybrids occur. Overall, hybridization, morphological similarity, and electrophoretic data all suggest a close relationship between the species. These findings possibly suggest that the chemotaxonomic subgroupings may not be reflective of phylogeny. In either case this hybrid complex warrants further investigation.

TAXONOMIC TREATMENT

Herbaceous perennials with woody crown and tough roots; leaves very short-petioled, palmately compound with 3 leaflets (or uppermost with only 1 or 2); stipules large to small, persistent or falling early; flowers terminal, large, solitary or in erect to horizontal or drooping racemes or solitary in the leaf axils; corollas variously colored; stamens 10, separate; fruit rounded or subcylindric, becoming woody, often with a beak. The plants are avoided by grazing animals; some species are reportedly toxic to livestock.

Baptisia nuttalliana Small occurs in north central Texas to the south of the study area but is not involved in the hybrid complex discussed here. It can be distinguished by the yellow flowers occurring singly in the upper leaf axils (at least some) or in very short terminal racemes with 1–4 flowers. The only other Texas *Baptisia* species is *B. alba* (L.) Ventenat var. *macrophylla* (Larisey) Isely [= *B. leucantha* Torr. & Gray], known only from sandy soil in east and southeast Texas. It is distinguished by its erect inflorescences with white flowers subtended by early deciduous bracts.

KEY TO NORTH CENTRAL TEXAS *BAPTISIA* PARENTAL AND HYBRID TAXA

1. Petals cream; inflorescence held distinctly below the level of the leaves; vegetative structures densely pubescent *B. bracteata*
1. Petals blue-violet to yellow, orange, or brick-red, but not cream; inflorescence at least partially erect and held above the level of the leaves or solitary in the upper leaf axils; vegetative structures glabrous to moderately pubescent.
 2. Petals blue-violet (keel sometimes whitish); stems at base thick (>5 mm diam.); plants usually growing individually; inflorescences one to a few per plant.
 3. Petals intensely to moderately blue-violet; inflorescence vertical (strictly erect); plant glabrous and glaucous *B. australis*
 3. Petals moderately to pale blue-violet; inflorescence angled about 45°; plant slightly pubescent, not glaucous *B. × bicolor*
 2. Petals yellow or multicolored; stems at base thin (<5 mm diam.); plants usually growing in dense clusters; inflorescences usually numerous per plant.
 4. Petals yellow, all ± the same color; foliage glabrous to moderately pubescent.
 5. Petals vividly yellow; raceme nearly vertical (strictly erect); vegetative portions of the plant glabrous *B. sphaerocarpa*
 5. Petals pale yellow; raceme angled about 45°; vegetative portions of the plant moderately pubescent *B. × bushii*
 4. Petals brick-red and yellow to orangish to blue-violet and yellow, different petals of the same flower often of different colors; foliage glabrous *B. × variicolor*

***Baptisia australis* (L.) R. Br. ex W.T. Aiton var. *minor* (Lehm.) Fern., Rhodora 39:312. 1937.**

Baptisia minor Lehm., Ind. Seimin. Hort. Hamb. 16. 1827.

Baptisia minor var. *aberrans* Larisey, Ann. Missouri Bot. Gard. 27:206. 1940.

Baptisia texana Buckl., Proc. Acad. Nat. Sci. Philadelphia 13:452. 1861.

Baptisia versicolor Loddiges, Bot. Cab. 12: pl. 1144. 1826.

Baptisia vespertina Small ex Rydb., Fl. Prairies & Plains Central N. Amer. 456. 1932.

Plants usually growing individually, tall (usually 46–74 cm), of strictly erect habit, with a single, thick (>5 mm diam.), glaucous stem rising from the ground several cm before branching; branches generally few and rigid; leaves small (center leaflet 18–34 mm long, average 25 mm) and glabrous; stipules small (4–11(–22) mm long); flowers borne on a usually single,

rigidly erect raceme; floral bracts early deciduous; pedicels 5–15 mm long; corollas large (27–36 mm long), blue-violet of variable intensity; fruit usually much longer than wide, 30–60 mm long, 20–30 mm wide, with a distinct persistent beak that is noticeably widened at base, black at maturity, glabrous. Clay soil, prairies, pastures; Fannin and Grayson cos. in Red River drainage, also Collin Co., also Dallas Co. (Mahler 1988); otherwise only known in Texas from the Panhandle and Titus Co. to the east. Flowering Apr.

Baptisia* × *bicolor Greenm. & Larisey (*B. australis* × *B. bracteata*), Amer. J. Bot. 26:539. 1939.

Plants usually growing individually, intermediate to both parents in numerous characters, of medium height (30–60 cm tall), generally branching at or near the ground; stems and foliage moderately pubescent; leaves and stipules of moderate length (center leaflet 27–51 mm long; stipules 4–10 mm long); flowers borne on 1–several racemes angled about 45° above the ground; floral bracts early deciduous; pedicels 10–18 mm long; corollas large (27–33 mm long), light to medium blue-violet. Prairies, pastures, soils often intermediate between clay and sand or soil types in close proximity; Red River drainage, Fannin and Grayson cos. Flowering Apr.

***Baptisia bracteata* Muhl. ex Ell. var. *leucophaea* (Nutt.) Kartesz & Gandhi**, Phytologia 71:276. 1991.

Baptisia bracteata var. *glabrescens* (Larisey) Isely, Brittonia 30:470. 1978.

Baptisia leucophaea Nutt., Gen. N. Amer. Pl. 1:282. 1818.

Baptisia leucophaea var. *glabrescens* Larisey, Ann. Missouri Bot. Gard. 27:161. 1940.

Lasinia bracteata Raf., New Fl. N. Amer. 2:84. 1910.

Plants usually growing individually, low (21–36 cm tall), often wider than tall, branching at or near the ground, with all vegetative parts densely pubescent; leaves and stipules large (center leaflet 30–60 mm long; stipules 10–40 mm long); flowers on reclining or hanging racemes; floral bracts persistent and large (10–30 mm long); pedicels long (15–35 mm long); corollas large (25–38 mm long); fruit (2–)3–4(–5) cm long, 1.5–2.5 cm wide, tapering to a slender beak (wide at base), black, pubescent or rarely later glabrate. Sandy open woods, prairies, pastures, and roadsides; East Texas west to East Cross Timbers. Flowering late Mar–Apr.

Baptisia* × *bushii Small (*B. bracteata* × *B. sphaerocarpa*), Fl. SE U.S. 600. 1903.

Baptisia × *intermedia* Larisey, Ann. Missouri Bot. Gard. 27:165. 1940.

Baptisia × *stricta* Larisey, Ann. Missouri Bot. Gard. 27:166. 1940.

Plants usually growing individually, intermediate to both parents in numerous characters, low (26–36 cm tall), branching at or near the ground; stems and foliage moderately pubescent; leaves and stipules moderate to

large (center leaflet 42–60 mm long; stipules 7–34 mm long); flowers on several racemes angled about 45° above the ground; floral bracts early deciduous; pedicels 7–15 mm long; corollas medium-sized (22–29 mm long), light to medium yellow. Usually on sandy soil; Red River drainage, Fannin and Grayson cos. Flowering Apr.

Baptisia sphaerocarpa Nutt., J. Acad. Nat. Sci. Philadelphia 7:97. 1834.

Baptisia viridis Larisey, Ann. Missouri Bot. Gard. 27:196. 1940.

Plants often growing in a dense cluster with a number of apparently identical individuals in close proximity, suggesting vegetative spread, tall (40–70 cm) and of generally erect habit, with 1-many small, flexible, glabrous stems, branching close to the base and often; leaves large (center leaflet 36–67 mm long), the upper leaves often reduced to 1–2 leaflets; stipules small (2–5(–6.1) mm long) to absent; flowers borne on 1-many flexible vertical racemes; floral bracts early deciduous; pedicels short (1–7 mm long); corollas small (17–25 mm long), intensely yellow; fruit subspheroid, 1.4–1.8 mm in diam., usually light brown [Isely (1990) also reports black], glabrous; in north central Texas the small, nearly round, light brown fruits immediately distinguish *B. sphaerocarpa* from the other two parental species with larger, elongate, black fruits. Sandy or silty clay; east Texas west to western Blackland Prairie (Grayson Co.). Flowering Apr–May.

Baptisia × variicolor Kosnik, Diggs, Redshaw, & Lipscomb, nothosp. nov. (Figs. 1 & 3)

Inter parentes *B. australem* (L.) R. Br. ex W.T. Aiton et *B. sphaerocarpan* Nutt. habitu intermedia, florum colore e lateritio, flavo vel aurantio violascenti vel lutescenti recognitur. (*B. australis* × *B. sphaerocarpa*).

Plants often growing in a dense cluster with a number of apparently identical individuals in close proximity, suggesting vegetative spread, intermediate to both parents in numerous characters, but vegetatively often more similar to *B. sphaerocarpa* than *B. australis*, tall (40–76 cm) and of generally erect habit, with 1-many small, flexible, glabrous stems, branching at or near the base and often; leaves medium-sized (center leaflet 30–50 mm long); stipules small (3–15 mm long) to absent; flowers borne on 1-many flexible vertical racemes; floral bracts early deciduous; corollas of intermediate size (22–27 mm long), brick-red and yellow to orangish to bluish-violet and yellow. Prairies, pastures, soils often intermediate between clay and sand or soil types in close proximity; Red River drainage, Fannin and Grayson cos. Flowering Apr–May. Named for the extremely variable flower color. The epithet is spelled *variicolor*, so that the first “i” is part of the root, *vari*.

TYPE: U.S.A. TEXAS: Fannin Co.: 5 mi E of Whitewright, in Ely Community, on Farm Road 898, unplowed native prairie remnant, 33° 31' N, 96° 20' W, elevation 253 m, 25 Apr 1996, Kosnik, Diggs, & Wolford 108 (HOLOTYPE: BRIT; ISOTYPES: BRIT, TEX, US).

CONCLUSIONS

Morphological and spectrophotometric data are consistent with the hypothesis that visually intermediate individuals from Grayson and Fannin counties, Texas represent hybrids between the three locally sympatric species. At two study sites there are previously undocumented hybrid swarms of all three parental species and all three F_1 hybrids. Variation suggestive of backcrossing between parents and hybrids and introgressive hybridization was also observed. The range of the hybrids, *B. × bushii* and *B. × bicolor*, has been extended to include populations from north central Texas and a new hybrid, *B. × variicolor* is described. This hybrid is morphologically intermediate and additive in terms of flower color between the parents, but is often vegetatively more similar to *B. sphaerocarpa*; the variable brick-red and yellow to orangish to bluish-violet and yellow coloration of the flower is distinctive. The coloration and absorbance data suggest a summation of the parental pigment pathways, with both parental pigments being expressed in *B. × variicolor*. In the study area this hybrid only occurs where different soils are in close proximity or where soils are of an intermediate or mixed nature.

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NOTEWORTHY *CAREX*, *CYPERUS*, *ELEOCHARIS*,
KYLLINGA, AND *OXYCARYUM* (CYPERACEAE)
FROM ALABAMA, ARKANSAS, GEORGIA,
LOUISIANA, MISSISSIPPI, NORTH CAROLINA,
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ABSTRACT

Field explorations have yielded *Carex austrina* new to North Carolina and Tennessee, *Carex fissa* var. *aristata*, *Cyperus ochraceus*, and *Eleocharis macrostachya* new to Mississippi, *Carex oklahomensis* new to Tennessee, *Cyperus lanceolatus* new to Georgia and Mississippi, *Cyperus difformis*, *C. oxylepis*, and *C. pumilus* new to Georgia, *Cyperus eragrostis* new to Louisiana, *Cyperus surinamensis* new to Tennessee and *Oxycarum cubense* new to Georgia, U.S.A. Additional range extensions are presented for *Carex hyalina*, *C. oklahomensis*, *C. scoparia* var. *scoparia*, *Cyperus aggregatus*, *C. difformis*, *C. lancastriensis*, *C. pilosus*, *Kyllinga brevifolioides* and *Oxycaryum cubense*. Localities, habitat data, lists of associated species, and discussions of weed potential are presented.

RESUMEN

Exploraciones de campo han dado como resultado la aparición de *Carex austrina* nuevo para Carolina del Norte y Tennessee, *Carex fissa* var. *aristata*, *Cyperus ochraceus*, y *Eleocharis macrostachya* nuevos para Mississippi, *Carex oklahomensis* nuevo para Tennessee, *Cyperus lanceolatus* nuevo para Georgia y Mississippi, *Cyperus difformis*, *C. oxylepis*, y *C. pumilus* nuevos para Georgia, *Cyperus eragrostis* nuevo para Louisiana, *Cyperus surinamensis* nuevo Tennessee, y *Oxycarum cubense* nuevo para Georgia, U.S.A. Se presentan extensiones de área

de *Carex byalina*, *C. oklahomensis*, *C. scoparia* var. *scoparia*, *Cyperus aggregatus*, *C. difformis*, *C. lancastriensis*, *C. pilosus*, *Kyllinga brevifolioides* y *Oxycaryum cubense*. Se ofrecen localidades, datos del hábitat, listas de especies asociadas, y discusiones de su potencial como malas hierbas.

INTRODUCTION

Field work on the *Carex*, *Cyperus*, *Eleocharis*, and *Kyllinga* for the Flora of Mississippi Project during the past few years has resulted in numerous discoveries of species new to Mississippi (Bryson 1984a; Morris & Bryson 1986; Carter et al. 1987; Bryson & Jones 1990; Carter et al. 1990; Naczi & Bryson 1990; Bryson et al. 1991; Bryson et al. 1992; Bryson & Carter 1992; Bryson & Carter 1994; Bryson et al. 1994). Current work has also increased the knowledge of *Carex*, *Cyperus*, *Eleocharis*, and *Kyllinga* species in Mississippi and surrounding states, taxa that are weeds, potential weeds, or are poorly known even elsewhere within their ranges. The flora of Mississippi is still poorly known in comparison to several adjacent states (Bryson & Carter 1994). Lowe's *Plants of Mississippi* (1921) and Small's *Manual of the Southeastern Flora* (1933), although outdated, must continue to serve as the baseline for the general flora of Mississippi.

Terminology of physiographic regions or resource areas in Mississippi follows Lowe (1921) as modified by Morris (1989). Other references dealing exclusively with *Carex*, *Cyperus*, *Eleocharis*, and *Kyllinga*, which we have used as sources for distributional data are Kükenenthal (1935–1936), Mackenzie (1931–1935), McGivney (1938), Corcoran (1941), Horvat (1941), and Svenson (1957). Herbarium abbreviations follow Holmgren et al. (1990), except ctb, MMNS, and USMH (pers. herb. of Charles T. Bryson, Mississippi Museum of Natural Science at Jackson, and University of Southern Mississippi, Hattiesburg, respectively).

NOTEWORTHY COLLECTIONS

Carex austrina (Small) Mackenzie was described from Houston, Harris County, Texas, and is known from Arkansas, Kansas, Louisiana, Mississippi, Missouri, Oklahoma, and Texas (Jones 1994). It is herewith reported new to North Carolina and Tennessee. At the North Carolina site, *C. austrina* grew infrequently along an open roadside where hay was spread for erosion control. It is likely that *C. austrina* was introduced at the North Carolina and Tennessee sites in hay or as contaminates of grass seeds planted for erosion control.

Voucher specimens: U.S.A. **NORTH CAROLINA**. Stokes Co.: Hanging Rock State Park, Moores Wall Trail, NE of Moores Springs Road, nearest point of the lake and the main road., 11 May 1996, S. and G. Jones 12565 (BRCH, BRIT, ctb, NCU, MICH, VDB). **TENNESSEE**. Jackson Co.: Open, low field at Gainesboro Park, 3 May 1995, McNeilus 95-214 (TENN); 14 May 1995, McNeilus 95-191 (ctb, TENN).

Carex fissa Mackenzie var. **aristata** Hermann is reported new to Mississippi. *Carex fissa* was described by Mackenzie (1931) from specimens collected in eastern Oklahoma. Kolstad (1986) reported *C. fissa* from additional sites in Oklahoma and from eastern Kansas. Hermann (1965) described *C. fissa* var. *aristata* from north central Florida. Jones et al. (1990) reported *C. fissa* var. *fissa* from Texas. When *C. fissa* var. *fissa* was reported new to Mississippi (Bryson & Carter 1994), it was speculated that *C. fissa* var. *aristata* should be in southern Mississippi. The collection of *C. fissa* var. *aristata* was found along a drainage ditch on National Guard Camp Shelby in the Coastal Pine Meadows Region in association with *Carex frankii* Kunth, *C. longii* Mackenzie, *Cyperus compressus* L., *C. iria* L., *C. pilosus* Vahl, *C. strigosus* L., *Cuphea carthagenensis* (Jacq.) Macbr., *Eryngium prostratum* Nutt., *Iva annua* L., *Juncus debilis* Gray, *J. dichotomus* Ell., *J. validus* Cov., *Panicum dichotomiflorum* Michaux, *Paspalum urvillei* Steudel, *Sesbania exaltata* (Raf.) Rydb. ex Hill. Although the time of year for this collection is unusual, it is likely that *C. fissa* var. *aristata* will be found in additional sites in southern Mississippi.

Voucher specimens: U.S.A. MISSISSIPPI. Forrest Co.: Camp Shelby, NE of McLaurin, S of Forrest Ave. on seepage slope to W of Bldg. 3221, 15 Oct 1995, *Bryson 14525*, *MacDonald, Rankin, and Rosso* (ctb, MICH, SWSL).

Carex hyalina Boott is a member of section *Ovales* Kunth. Until recently, *C. hyalina* was a poorly understood species of the southern United States. Reznicek and Naczi (1993) presented a history of the taxonomic status, ecology, and distribution of *C. hyalina*. *Carex hyalina* is known from Arkansas, Louisiana, Mississippi, Oklahoma, and Texas (Mackenzie 1931; Waterfall 1960; Orzell & Bridges 1987; Naczi & Bryson 1990; Bryson et al. 1992; Reznicek & Naczi 1993; Thomas & Allen 1993b). The following record of *C. hyalina* is from an additional Mississippi county, within several miles of the Mississippi River. At this site, *C. hyalina* was found in an open seasonally wet ditch on a heavy, highly organic clay soil associated with *Carex corrugata* Fernald, *C. leavenworthii* Dewey, and *C. molesta* Mackenzie. This site deviates from other Mississippi *C. hyalina* sites because the plants grew in an open area rather than under a canopy of a typical bottomland hardwoods forest.

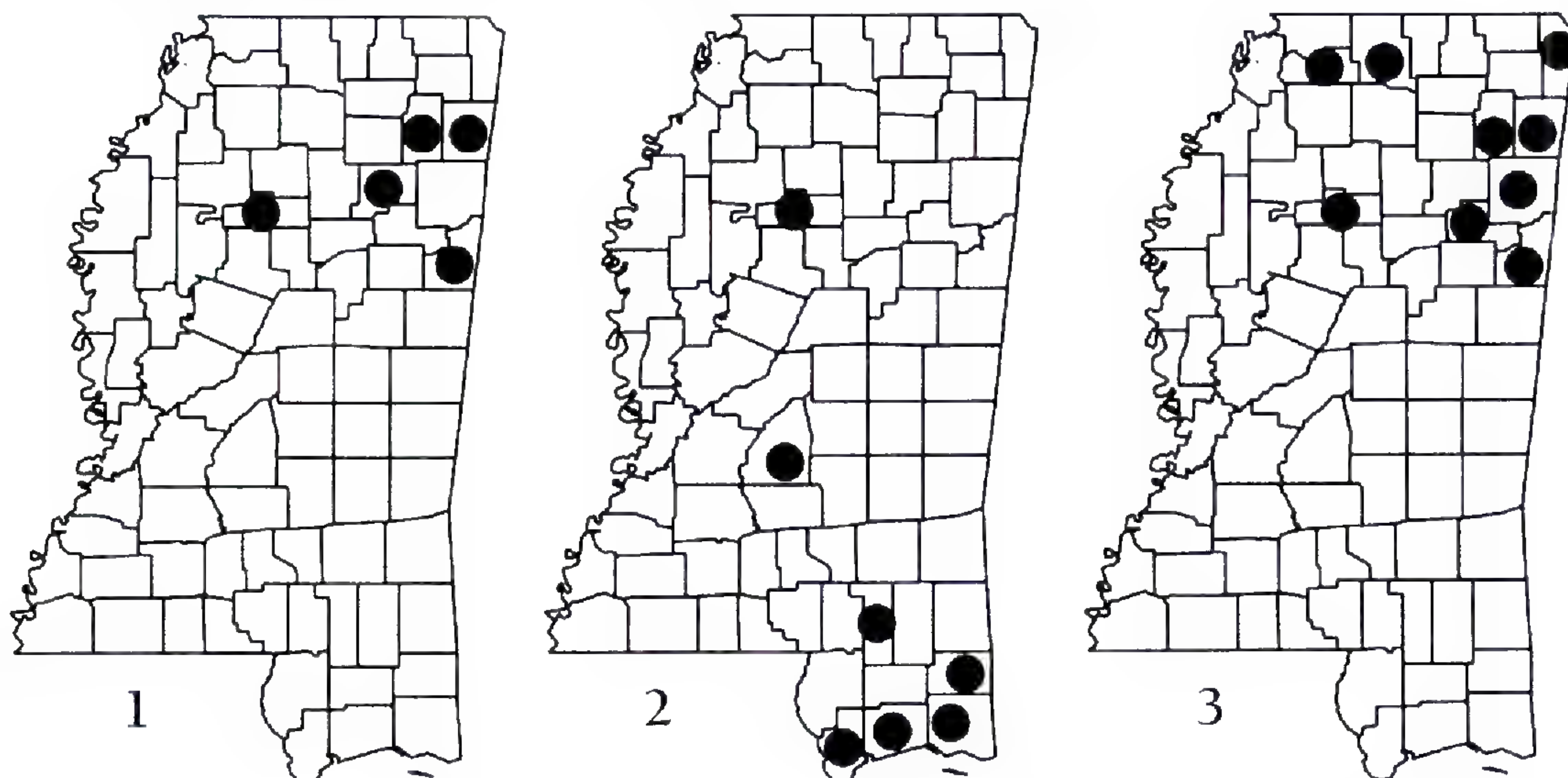
Voucher specimens: U.S.A. MISSISSIPPI. Washington Co.: Greenville, N of jct. Hwy US 82 and S Broadway St., T18N R8W Sect. 21 near center, 6 May 1996, *Bryson 15073* (BRCH, BRIT, ctb, DSC, GA, GH, IBE, KNK, MICH, MISS, MMNS, MO, NLU, NY, NYS, SWSL, TENN, UARK, UNLV, USMH, VDB, VPI, VSC, WIS, additional specimens to be distributed).

Carex oklahomensis Mackenzie is known from Arkansas, Mississippi, Missouri, North Carolina, Oklahoma, and Texas (Mackenzie 1931; Steyermark 1963; Bryson et al. 1992; Jones et al. 1991, Jones & Reznicek

1995). The first report of *C. oklahomensis* from Mississippi (Bryson et al. 1991) was from a recent roadside construction area near Tupelo, Lee County, and from additional sites in Itawamba, Lee, and Lowndes counties (Bryson et al. 1994). The following are the first report of *C. oklahomensis* for Tennessee and additional county records for Mississippi. Like the other Mississippi records, the following collections of *C. oklahomensis* are from a construction site where hay was blown for erosion control and in an improved, grass-seeded but weedy pasture. At the Chicksaw County location cited below, *C. oklahomensis* grew on a wet heavy clay soil in the Black Prairie Region in association with *Carex frankii*, *C. longii*, *C. triangularis* Boeckeler, *C. vulpinoidea* Michaux. In Grenada County, *C. oklahomensis* grew in association with *Allium canadense* L., *Alopecurus carolinianus* Walt., *Axonopus furcatus* (Fluegge) Hitchc., *Carex longii*, *C. triangularis* Boeckeler, *Festuca elatior* L., *Juncus acuminatus* Michaux, *J. effusus* L., *Krigia cespitosa* (Raf.) Chambers, *K. oppositifolia* Raf., *Panicum scoparium* Lamarck, *Ranunculus platensis* Sprengel, and *R. sardous* Crantz on a silty soil. At the Hunt's Lake site in Grenada County, more than 1,000 large clumps of *C. oklahomensis* were scattered over a 15 ha area. The distribution of *C. oklahomensis* in Mississippi is presented in Fig. 1.

Voucher specimens: U.S.A. **MISSISSIPPI**. Chickasaw Co.: W of Houston, 2 mi W of jct. Hwys. MS 8 and MS 15, at jct. of bypass construction of Hwys. MS 8 and MS 15, 22 Jun 1995, *Bryson 14834 and MacDonald* (ctb, SWSL); 20 May 1996, *Bryson 15237* (ctb, IBE, MICH, MISS, MMNS, MO, SWSL, USMH, VDB, VSC, additional specimens to be distributed). Grenada Co.: Camp McCain, ca. 1.5 mi SSW of jct. of Firetower Rd. and Grant Rd., T21N R5E Sect. 1 W/4 of NE/4, above lake on old Hunt property, 14 May 1996, *MacDonald 9400* (BRCH, BRIT, ctb, DSC, GA, GH, IBE, KNK, MICH, MISS, MMNS, MO, NLU, SWSL, TENN, UARK, UNLV, USMH, VDB, VPI, VSC, WIS, additional specimens to be distributed); 20 May 1996, *Bryson 15190 and MacDonald* (BRCH, ctb, IBE, MICH, NLU, VDB, VSC, additional specimens to be distributed); Camp McCain, edge of Quartermaster Rd. at 0.25 mi S of jct. with Squadron Rd., T21N R6E Sect. 11 W/4, 28 May 1996, *MacDonald 9480* (BRCH, ctb, IBE, MICH, SWSL, additional specimens to be distributed). **TENNESSEE**. Haywood Co.: Hatchie, 5 mi S Brownsville, exposed edge of Big Lake, 28 May 1996, *McNeilus s.n.* (ctb, additional specimens to be distributed). Morgan Co.: Exposed edge of farm pond, about 0.5 mi N of Cumberland Co. line along Rt. 299, 19 Jun 1996, *McNeilus s.n.* (ctb, TENN).

Carex scoparia Willd. *scoparia* is known from Newfoundland to British Columbia, south to South Carolina, Tennessee, Mississippi, Arkansas, Oklahoma, New Mexico, and Oregon (Bryson et al. 1994; Kolstad 1986; Mackenzie 1931; Radford et al. 1964; Steyermark 1963). The following data are the second report of *C. scoparia* var. *scoparia* from Mississippi, the first from the Longleaf Pine Belt Region, and a range extension southward by about 170 mi (272 km). At this site, it grew on logs and stumps in and along the edges of Simpson Legion Lake in association with *Carex atlantica* Bailey and *C. leptalea* Wahl.



FIGS. 1–3. Fig. 1. Documented distribution of *Carex oklahomensis* in Mississippi. Fig. 2. Documented distribution of *Cyperus difformis* in Mississippi. Fig. 3. Documented distribution of *Cyperus lancastricensis* in Mississippi.

Voucher specimens: U.S.A. MISSISSIPPI. Simpson Co.: SE side of Simpson Legion Lake, N of Hwy. US 49, T1N R5E Sect. 21 NE/4, 30 Apr 1996, *Bryson 15064* (ctb, IBE, MICH, MO, SWSL).

Cyperus aggregatus (Willd.) Endl. is a neotropical perennial weed, apparently introduced into the southeastern United States. It is known from Florida (Kral 1966; Clewell 1985), Louisiana (Horvat 1941), Texas (Correll & Johnston 1970), and Mississippi (Bryson & Carter 1992). Although it has been reported as *C. cayenensis* (Lam.) Britton, *C. flavus* (Vahl) Nees, and *C. huarmensis* (H.B.K.) M.C. Johnston, Tucker (1985) determined *C. aggregatus* to be the correct name for this taxon. The following are the first records of *C. aggregatus* from Pearl River County where, like the other reported sites in Mississippi, it is an aggressive weed of open sandy hilltops and roadsides of the Longleaf Pine Region in association with *Cyperus compressus*, *C. croceus* Vahl, *C. echinatus* (L.) Wood, *C. esculentus* L., *C. retrorsus* Chapman, and *C. rotundus* L.

Voucher specimens: U.S.A. MISSISSIPPI. Pearl River Co.: Poplarville, 0.2 mi W of jct. Hwys. MS 26 and MS 53, 0.5 mi E of jct. Hwys. US 11 and MS 26, S of Hwy. MS 26, T2S R15W Sect. 20, 15 Aug 1994, *Bryson 14190* (BRCH, BRIT, ctb, DSC, GA, GH, IBE, KNK, MICH, MISS, MMNS, MO, NLU, NY, NYS, SWSL, TENN, UARK, UNLV, USMH, VDB, VPI, VSC, WIS, additional specimens to be distributed); 8.6 mi W jct. Hwys. US 11 and MS 26, S of Hwy. MS 26, W of Poplarville, T3S R17W Sect. 11, SW/4 of SW/4, 15 Aug 1994, *Bryson 14197* (BRCH, ctb, GH, IBE, KNK, MICH, MISS, MMNS, MO, NLU, SWSL, TENN, UARK, USMH, VDB, VPI, VSC, WIS, additional specimens to be distributed).

Cyperus difformis L., smallflower umbrella sedge, is considered the

thirty-second world's worst weed (Holm et al. 1977). It is a particularly pernicious weed because of its rapid generation time and high reproductive potential. *Cyperus difformis* has the capability of producing several generations per year (seed to seed in 4 to 6 weeks) and can reach 60% of the total biomass in rice production in Asia (Holm et al. 1977). In the United States, *C. difformis* was first collected from Butte County, California in 1915 (Lipscomb 1980), but the first published report of this species was based on a 1921 collection from Butte County, California (Howell 1934). In the eastern United States, *C. difformis* has been known since 1934 from Virginia, where the source of introduction was probably rice-straw used in packing (Fernald 1935).

More recently, *C. difformis* was reported from New Mexico (McGivney 1938), Arizona (Kearney & Peebles 1942), Louisiana (Thieret 1964), Nebraska (Lemaire 1970), Alabama (Kral 1973), North Carolina (Tyndall et al. 1977; Tyndall 1983), Texas (Lipscomb 1980; Carr 1988), Florida (Burkhalter 1985), Tennessee (Webb & Dennis 1981), Pennsylvania (Smith 1986), Mississippi (Bryson & Carter 1992), and Kentucky (Mears & Libby 1995). The occurrence, range expansion, and habitat requirements for *C. difformis* in the United States are discussed by Lipscomb (1980) and Tyndall (1983).

Since its introduction, *C. difformis* has become a troublesome weed of rice in California (Bryson 1984b; Hill et al. 1994). During the past five years, populations of *C. difformis* have become resistant to bensulfuron, a sulfonylurea herbicide, at 72 sites in California (Pappas-Fader et al. 1993; Pappas-Fader 1994; Hill et al. 1994). In the future, *C. difformis* may threaten rice production in the Mississippi River alluvial flood plain and its tributaries. Currently, the Mississippi populations of *C. difformis* are restricted to roadside ditches or other low, wet, disturbed areas often near ports of entry or heavily utilized truck and railroad routes, but *C. difformis* seems to be spreading. Associates of *C. difformis* at the Mississippi sites include *Cyperus erythrorhizos* Muhl., *C. iria*, *C. odoratus* L., *Eleocharis obtusa* (Willd.) Schultes, *Fimbristylis miliacea* (L.) Vahl, *Kyllinga brevifolia* Rottb., *Ludwigia decurrens* Walter, and *Polygonum hydropiperoides* Michaux.

In southern Georgia *C. difformis* was a locally common emergent at the margin of a shallow artificial pond where it was associated with *Axonopus affinis* Chase, *Cyperus erythrorhizos* Muhl., *C. haspan* L., *C. polystachyos* Rottb., *Eclipta alba* (L.) Hassk., *Eleocharis tuberculosa* (Michx.) R. & S., *Hydrochloa caroliniensis* Beauv., *Juncus* spp., *Lipocarpus maculata* (Michx.) Torr., *Ludwigia* spp., *Pontederia lanceolata* Nutt., *Rhynchospora corniculata* (Lam.) Gray, *Sagittaria graminea* Michx., *Salix nigra* Marsh., *Typha latifolia* L., and *Xyris* spp. In Texas *C. difformis* grew in wet, deep alluvial sand where it was associated with *Acer saccharinum* L., *Betula nigra* L., *Campsis radicans* (L.)

Seem. ex Bureau, *Cyperus croceus*, *C. retrorsus*, *Echinochloa walteri* (Pursh) Heller, *Eleocharis obtusa*, *Eragrostis glomerata* (Walt.) Dewey, *E. hypnoides* (Lam.) Britt., *E. secundiflora* Presl, *Eupatorium* sp., *Fimbristylis vahlia* (Lam.) Link, *Juncus diffusissimus* Buckley, *Panicum acuminatum* Sw., *P. commutatum* Schultes, *P. rigidulum* Bosc ex Nees, *Populus deltoides* Marsh., *Salix nigra* Marsh., and *Vitis* sp.. Following are the first report of *Cyperus difformis* from Georgia; the first report from southern Alabama, the species previously having been reported from Limestone County in northern Alabama (Kral 1973); the first report from peninsular Florida (Wunderlin 1982), the species having been previously reported only from the Florida panhandle (Burkhalter 1985); the first report from eastern Texas, the species having been previously reported only from the Edwards Plateau Plateau (Lipscomb 1980; Carr 1988); and additional records from three Mississippi counties in the North Central Plateau, the Longleaf Pine Belt, and Coastal Pine Meadows physiographic regions (Fig. 2).

Voucher specimens: U.S.A. **ALABAMA**. Mobile Co.: Mobile, 0.95 mi W jct. Hwys. US 90 and AL 163 south, concrete storm drain along Commercial Blvd., S of Hwy. US 90, adjacent to bus terminal, 12 Sep 1995, *Carter 12711* (VSC, additional specimens to be distributed). **FLORIDA**. Orange Co.: Orlando, jct. Hwy. I-4 and Florida Turnpike, barrow pit and adjacent disturbed bayswamp near toll gate, 15 Apr 1994, *Carter 11769* (VSC, additional specimens to be distributed). **GEORGIA**. Lanier Co.: Moody Air Force Base, Winnersville Bombing Range, shallow artificial ponds near NE corner of range, vicinity of observation tower, 27 Aug 1994, *Carter 11899* (VSC, additional specimens to be distributed). **MISSISSIPPI**. Forrest Co.: Camp Shelby, NE of McLaurin, potable water station on Forest Ave., 15 Oct 1995, *Bryson 14517*. *MacDonald, Rankin, and Rosso* (ctb, SWSL, VSC). **Grenada Co.**: Camp McCain, Area 2, T21N R6E Sect. 7 NW/4, 12 Jul 1994, *MacDonald 7335* (BRCH, ctb, IBE, SWSL, VDB, VSC). **Rankin Co.**: Richland, 3.6 mi S of jct. Hwys. I-20 and US 49, 19 Oct 1994, *Bryson 14651* (BRCH, ctb, IBE, MICH, MISS, MMNS, MO, NLU, SWSL, TENN, UNLV, USMH, VDB, VSC); 2.9 mi S of jct. Hwys. I-20 and US 49, 19 Oct 1994, *Bryson 14652* (ctb, GH, SWSL, VSC). **TEXAS**. Newton Co.: 0.1 mi E on TX 190 from its jct. with FR 1416 in Bon Weir, then 0.6 mi on an un-named paved road, then 1.6 mi E on another un-named paved road to the W-bank of the Sabine River, S of Bon Weir, open to partially wooded riverine habitat with alluvial, deep sands, occasional, 27 Jul 1990, *S. and G. Jones 5614 and J. Wipff* (MICH).

Cyperus eragrostis Lamarck is known from California, Oregon, Washington, Texas, and British Columbia in North America; Argentina, Bolivia, Brazil, Chile, Peru, Surinam and Uruguay in South America; Easter and Juan Fernandez Islands in the Pacific (Denton 1978; Tucker 1987; Tucker 1994). *Cyperus eragrostis* has been reported as a waif in South Carolina (Tucker 1987), and it was first reported from Mississippi by Bryson and Carter (1994). Tucker (1987) reported that it has become naturalized in southern Europe and southeastern Texas. This weedy perennial seems to be spreading in Mississippi and should be expected in other southeastern states. It was not reported in the Atlas of the Vascular Flora of Louisiana

(Thomas and Allen 1993a). The following data are for the first report of *C. eragrostis* from Louisiana, where it grew in open wet areas on clay soil in association with *C. difformis*, *C. elegans*, *C. iria*, *C. ochraceus*, *C. odoratus*, *C. oxylepis*, *C. squarrosus*, and *C. surinamensis*. Additional records from the Coastal Pine Meadows and the Longleaf Pine Belt regions of Mississippi are presented.

Voucher specimens: U.S.A. LOUISIANA. St. Bernard Parish: Chalmette, St. Bernard Port area to W of Chalmette National Historical Park, 28 Jul 1994, *Bryson 14012* (ctb, NLU, SWSL, VSC). MISSISSIPPI. Hancock Co.: N of Waveland, ca. 2 mi N of jct. Hwys. US 90 and MS 43, E of Hwy. MS 43, 17 Oct 1994, *Bryson 14576 and MacDonald* (ctb, VSC). Hinds Co.: Jackson, jct. I-55 and High Street, 28 Jun 1995, *Bryson 14866* (BRCH, ctb, IBE, MICH, SWSL, VDB, VSC). Perry Co.: New Augusta, NE of jct. and Hwys. US 98 and MS 29, 7 Sep 1994, *Bryson 14344* (ctb, DSC, GA, GH, IBE, MICH, MISS, MMNS, MO, NLU, NY, NYS, SWSL, TENN, USMH, VDB, VPI, VSC, WIS); 19 Oct 1994, *Bryson 14641* (ctb, IBE, MICH, MISS, USMH, VSC). Rankin Co.: Flowood, 1.1 mi W of jct. Hwys. MS 25 and MS 475, 28 Jun 1995, *Bryson 14867* (BRCH, ctb, IBE, MICH, MISS, MMNS, MO, NLU, SWSL, VDB, VSC).

Cyperus lancastricensis Porter in Gray was first reported from Mississippi by Morris (1988) from Grenada County in the North Central Plateau Region. Subsequently, it was reported from Itawamba, Lee, and Tishomingo counties in the Tennessee River Hills Region and from Tate and Marshall County in the North Central Plateau Region (Bryson & Carter 1992; Bryson & Carter 1994). The following additional county records for *C. lancastricensis* in Mississippi are from the Black Prairie Region (Clay County), the transition from the Black Prairie and Tennessee River Hills regions (Lowndes County), and the Tennessee River Hills (Monroe County). As previously reported (Bryson & Carter 1992; 1994), *C. lancastricensis* was growing in association with *C. echinatus* and *C. strigosus*. The distribution of *C. lancastricensis* in Mississippi is presented in Fig. 3.

Voucher specimens: U.S.A. MISSISSIPPI. Clay Co.: West Point, W of Hwy. US 45 Alt.; 0.5 mi S of jct. Hwys. US 45 Alt. and MS 50, 10 Aug 1994, *Bryson 14169 and Byrd* (BRCH, ctb, IBE, NLU, SWSL, TENN, USMH, VSC, additional specimens to be distributed). Monroe Co.: N of Monroe-Lowndes Co. line, where US Hwy. 45 crosses Buttahatchee River, 4 Sep 1994, *MacDonald 7584* (ctb). Lowndes Co.: Dwayne Hayes Recreational Area on Tennessee Tombigbee Waterway, T17S R18W Sect. 7 NW/4 of NW/4, 10 Jul 1994, *MacDonald 7308 and Warren* (ctb).

Cyperus lanceolatus Poiret is a pantropical weed (Kükenthal 1935-1936) known from northern Florida, where it occurs in marshy and boggy shorelines, seepage slopes, mucky ditches, wet sandy alluvial soils, wet clearings, and ditches (Godfrey & Wooten 1979). In the field, *C. lanceolatus* is similar in appearance, habit, and habitat to *C. flavescens* L., but it is readily distinguished by scales that are more golden yellow in color, by achenes that are orange-brown to brownish rather than black, and by narrower leaves. The habitat of *C. lanceolatus* in Mississippi is similar to and in some cases

the same as that for *Sacciolepis indica* (L.) Chase and *Cyperus louisianensis* Thieret, as recently reported from Mississippi (Bryson & Lockley 1993; Bryson & Carter 1994). At the following sites, *C. lanceolatus* grew on mucky sandy or clayey soils of the Coastal Plain in association with *Carex longii* Mackenzie, *Cyperus haspan*, *C. odoratus*, *C. polystachyos* Rottb., *C. pseudovegetus* Steudel, *C. strigosus* L., *C. surinamensis* Rottb., *Fimbristylis autumnalis* (L.) R. & S., *Fuirena breviseta* (Coville) Coville in Harper, *Kyllinga brevifolia*, *K. odorata* Vahl, *Lipocarpha maculata* (Michx.) Torr., *Eleocharis* sp., *Juncus* sp., *Rhynchospora glomerata* Vahl, *Sacciolepis indica*, *Xyris* sp., and in one site *Cyperus louisianensis* Thieret. Slopes above included *Cyperus ovatus* Baldwin and *C. retrorsus*. *Cyperus lanceolatus* is not included in Jones and Coile (1988). The following citations are the first reports of *C. lanceolatus* from Mississippi and Georgia.

Voucher specimens: U.S.A. **GEORGIA**. Brantley Co.: ditch by Hwy. US 82, 6 mi W of Hwy. US 301 in Nahunta, locally common, 21 Sep 1991, *Carter* 9229 (GA, IBE, MICH, NLU, NY, US, VDB, VSC). Camden Co.: Kings Bay Submarine Base, along unmarked paved road by west end dredge disposal area, ca. 700 m N of U.S.S. Mariano Vellajo Avenue, open seepy slope along ditch, 9 Jul 1996, *Carter* 13180 (VSC, additional specimens to be distributed). Charlton Co.: Along road to Folkston Airport, 17 Aug 1980, *McNeilus* 20 (ctb); mucky seepage slope along Hwy. GA 121, 10.7 mi N of Hwy. GA 94 in St. George, 9 Jul 1991, *Carter & Jones* 8855 (VSC, etc.); seepage slope along Hwy. GA 252, just N of Mays Bluff Branch, ca. 6 mi N of Folkston, 9 Jul 1991, *Carter & Jones* 8859 (VSC, etc.). Clinch Co.: 12.2 mi S of Homerville, sandy ditch bottom in flatwoods beside Hwy. GA 187, 2 Sep 1987, *Carter* 6313 (FLAS, GA, IBE, MO, NLU, NY, SWSL, US, VDB, VSC). Echols Co.: cut-over flatwoods, edge of shallow pond, S of Hwy. GA 94, 9.6 mi E of Hwy. US 129 in Statenville, 9 Jul 1991, *Carter & Jones* 8815 (FLAS, GA, IBE, MICH, MISSA, MO, NLU, NY, NYS, TAES, US, VDB, VSC). Lowndes Co.: 1.5 mi E of Valdosta jct. Hwys. US 41 and US 221, disturbed sandy loam along S side of Hwy. US 221, 27 Aug 1994, *Carter* 11900 (VSC, additional specimens to be distributed); jct. Rts. 94 and 135, exposed roadside, 5 Sep 1991, *McNeilus* 91-1167 (ctb). **MISSISSIPPI**. Hancock Co.: Mississippi Welcome Center, SW of jct. Hwys. I-10 and MS 607, 17 Oct 1994, *Bryson* 14566 and *MacDonald* (ctb, NLU, SWSL, VDB, VSC); *MacDonald* 8062 and *Bryson* (IBE). Pearl River Co.: Picayune, 0.1 mi W jct. Hwys. I-59 and MS 43; between I-59 and Cooper St., N of Hwy. MS 43, 27 Jul 1994, *Bryson* 14005 (BRCH, ctb, DSC, GH, IBE, KNK, MICH, MISS, MMNS, MO, NLU, SWSL, UNLV, USMH, VDB, VSC, additional specimens to be distributed); 16 Aug 1994, *Bryson* 14250 (BRCH, BRIT, ctb, DSC, GA, GH, IBE, KNK, MICH, MISS, MMNS, MO, NLU, NY, NYS, SWSL, TENN, UARK, UNLV, USMH, VDB, VPI, VSC, WIS, additional specimens to be distributed); Picayune, along old Hwy. MS 43 S, W of of Hwy. jct. Hwys. I-59 and MS 43, 16 Aug 1994, *Bryson* 14245 (BRCH, ctb, IBE, SWSL, VSC, additional specimens to be distributed); Picayune, E of jct. Hwys. I-59 and MS 43 along both sides of Sycamore Rd. at jct. with George Mitchell Rd., 16 Aug 1994, *Bryson* 14252 (BRCH, ctb, GH, IBE, KNK, MICH, MISS, MMNS, MO, NLU, SWSL, TENN, UARK, USMH, VDB, VPI, VSC, additional specimens to be distributed); Picayune, NE of Picayune by Sycamore Rd. at jct. with Hwy. I-59, 7 Sep 1994, *Bryson* 14350 (ctb, IBE, NLU, SWSL, VSC, additional specimens to be distributed).

Cyperus ochraceus Vahl is a tufted perennial known from the Antilles and from Louisiana and Texas south through Mexico and Central America, and in Columbia, Venezuela, and Argentina (Denton 1978). Throughout its range, *C. ochraceus* occurs in open sandy, silty, or clayey soils of ditches, fields, pastures, swamps, lava flows, cleared depressions in pine-oak forests or subtropical forests, and near lakes or streams from sea level up to 2350 meters elevation (Denton 1978). In Mississippi, *C. ochraceus* grew on a clay soil with fragments of oyster shells, similar to the areas where the authors have observed this species near New Orleans, Louisiana. At the following site *C. ochraceus* grew in association with *Cyperus difformis*, *C. elegans* L., *C. entrerianus* Boeckeler, *C. esculentus*, *C. iria*, *C. oxylepis* Nees in Steudel, *C. pseudovegetus* Steudel, *C. surinamensis* Rottb., *C. virens* Michaux, *Eleocharis obtusa*, *Fimbristylis autumnalis* (L.) R. & S., *Kyllinga brevifolia*, and *Panicum repens* L. The following is the first report of this species from Mississippi.

Voucher specimens: U.S.A. MISSISSIPPI. Jackson Co.: Pascagoula, Bayou Cassotte Industrial Park Area, S of City Animal Shelter at end of Louise St., 0.4 mi S of Washington Ave., 28 Jul 1994, Bryson 14025 (ctb, IBE, MICH, MO, SWSL, VSC, additional specimens to be distributed).

Cyperus oxylepis Steudel is known from South America, the Caribbean (Kükenthal 1936), and coastal areas of the southeastern United States where it has been reported from southeastern Texas (O'Neill 1938), Louisiana (Thieret 1964), Mississippi (Bryson & Carter 1992), and South Carolina (Tucker 1987). Recently, *C. oxylepis* has been found in Georgia in highly disturbed coastal, dredge-filled sites with grayish-black soil, similar to sites in Mississippi. It was associated with *Atriplex arenaria* Nutt., *Batis maritima* L., *Chenopodium ambrosioides* L., *Conyza bonariensis* (L.) Cronq., *Heliotropium curassavicum* L., *Mollugo verticillata* L., *Phyla nodiflora* (L.) Greene, *Salsola kali* L., *Sarcocornia perennis* (Mill.) A.J. Scott, *Suaeda linearis* (Ell.) Moq., *Tamarix* sp. Following are the first records of this taxon from Georgia.

Voucher specimens. U.S.A. GEORGIA. Camden Co.: Kings Bay Submarine Base, dredge disposal area, 0.88 mi (air) WNW Warrior Wharf, open fill site with grayish black clay, between 30°47'11"N 81°30'52"W and 30°47'20"N 81°30'45"W, 8 Jul 1996, Carter 13100 (VSC, additional specimens to be distributed); dredge disposal area N of USS Mariano Vellajo Avenue, 1 mi (air) W Kings Bay, 9 Jul 1996, Carter 13152 (VSC, additional specimens to be distributed).

Cyperus pilosus Vahl is a weedy introduction into the United States from tropical and subtropical regions, possibly Asia. It is known from Asia, Australia, and West Africa (Kükenthal 1935-1936) and in the United States from Louisiana (O'Neill 1938), Florida (Burkhalter 1985), and Mississippi (Bryson & Carter 1992). Like *C. difformis*, *C. pilosus* is a common rice weed in Asia, and it is a threat to rice production in the United States (McGivney 1938). *Cyperus pilosus* is easily identified in the field (see Bryson & Carter

1992). The following data are the first reports of *C. pilosus* from Forrest County in the Longleaf Pine Belt Region of Mississippi.

Voucher specimens: U.S.A. **MISSISSIPPI**. Forrest Co.: Camp Shelby, potable water station on Forrest Ave., 21 Sep 1994, *MacDonald 7706 and Wyrick* (ctb, IBE, SWSL); Camp Shelby, NE of McLaurin, along Hartfield Creek, 15 Oct 1995, *Bryson 14509, MacDonald, Rankin, and Rosso* (ctb, IBE, SWSL, VSC, additional specimens to be distributed); Camp Shelby, NE of McLaurin, potable water station on Forrest Ave., 2.9 mi E of Warehouse Rd., 15 Oct 1995, *Bryson 14513 and MacDonald, Rankin, and Rosso* (ctb, additional specimens to be distributed); Camp Shelby, NE of McLaurin, S of Forrest Ave., 15 Oct 1995, *Bryson 14521, MacDonald, Rankin, and Rosso* (BRCH, ctb, IBE, MICH, MISS, NLU, USMH, VDB, VSC, additional specimens to be distributed).

Cyperus pumilus L. is widespread in the Old World, and in the New World is known from the West Indies and the United States (Kükenthal 1936). In the United States it is known only from Florida (Chapman 1889: as *Cyperus divergens* Kunth; Small 1933; Kükenthal 1936; Long & Lakela 1971; Godfrey & Wooten 1979; Wunderlin 1982; Clewell 1985). It is a diminutive, densely tufted annual of disturbed sandy loams. Following are collection data for *C. pumilus* in Georgia where it grew in association with *Cyperus croceus*, *C. compressus*, *C. esculentus*, *C. retrorsus*, *C. rotundus*, *C. surinamensis*, *Fimbristylis autumnalis*, *Kyllinga brevifolia*, *Eleocharis obtusa*, *Echinochloa crus-galli* (L.) Beauv., and *Juncus* spp.

Voucher specimens. U.S.A. **GEORGIA**. Clinch Co.: along railroad tracks in Fargo off Hwy. GA 94, just W of Hwy. US 441, 21 Sep 1982, *Gary F. Joye s.n.* (NLU-mixed with *Cyperus compressus* L., fragment and photocopy at VSC); 22 Oct 1994, *Carter 12373* (ctb, SWSL, VDB, VSC).

Cyperus surinamensis Rottb. is widespread and weedy in sandy coastal areas of the southeastern United States and has been reported inland in Arkansas, Oklahoma, and Kansas (Denton 1978). Smith (1978) reported *C. surinamensis* from Arkansas based on a report by Lipscomb (1978). This specimen later determined to be *C. acuminatus* Torrey & Hooker (E. B. Smith, person communication). Although these specimens, [*Locke s.n.* (UARK)] cited by Lipscomb (1978) and [*Harvey 4* (GH)] cited by Denton (1978), are immature both were verified as *C. surinamensis* by the authors. *Cyperus surinamensis* is not included in the *Checklist of the Vascular Plants of Tennessee* (Wofford & Kral 1993). The following data are the first reports of *C. surinamensis* from Tennessee and an additional county record for Arkansas. In Arkansas, *C. surinamensis* grew in association with *C. esculentus*, *C. erythrorhizos*, *C. iria*, *C. odoratus*, *C. polystachyos* Rottb., *C. pseudovegetus*, *C. rotundus*, *C. strigosus*, *Fimbristylis autumnalis*, *F. vahlia* (Lam.) Link, and *Lipocarpus micrantha* (Vahl) Tucker. In Tennessee, it grew in association with *C. acuminatus*, *C. compressus*, *C. croceus*, *C. echinatus*, *C. esculentus*, *C. flavicomis* Michaux, *C. iria*, *C. odoratus*, *C. rotundus*, *C. strigosus*, *Echinochloa crus-galli*, *Fimbristylis autumnalis*, and *F. miliacea*.

Voucher specimens: U.S.A. **ARKANSAS**. Chicot Co.: Lake Chicot, along shoreline across from jct. of Hwys. AR 144 and AR 257, 19 Sep 1994, *Bryson 14415 and Tidwell* (BRCH, BRIT, ctb, DSC, GA, GH, IBE, KNK, MICH, MISS, MMNS, MO, NLU, NY, NYS, SWSL, TENN, UARK, UNLV, USMH, VDB, VPI, VSC, WIS, additional specimens to be distributed). **TENNESSEE**. Shelby Co.: Memphis, S of Perkins Road at Mall of Memphis, 13 Sep 1993, *Bryson 13022 and Bryson* (ctb, VDB); Memphis, SW of jct. Perkins Road and American Way, NE of Mall of Memphis, 13 Oct 1993, *Bryson 13118* (ctb).

Eleocharis macrostachya Britton is essentially a western species, ranging from Saskatchewan, Alberta, and British Columbia southward to Louisiana, Texas, California, and into Mexico, and eastward into Illinois (Svenson 1957; Correll & Johnston 1970; Kolstad 1986; Cranfill 1993). It is a member of the *Palustres* complex and can be distinguished from related *E. smallii* Britton and *E. erythropoda* Steudel, by its conical tubercles, rigid compressed culms, and truncate sheaths (Svenson 1957; Harms 1968; Kolstad 1986). In Mississippi, *E. macrostachya* was locally abundant in roadside ditches on high hydroperiod clay soil in the Delta Region where it was associated with *Carex molesta* Mackenzie, *Echinochloa colonum* (L.) Link, *Juncus effusus* L., and *Sagittaria* spp. Following are the first records of *Eleocharis macrostachya* from Mississippi.

Voucher specimens: U.S.A. **MISSISSIPPI**. Washington Co.: Greenville, SW of jct. Hwy. US 82 with Raceway Road, ditch by Hwy. US 82, 9 May 1994, *Bryson 13435* (BRCH, ctb, IBE, MMNS, MO, SWSL, USMH, VDB, VSC, additional specimens to be distributed); 17 Jun 1996, *Bryson 15346 and Carter* (ctb, SWSL); *Carter 12940 and Bryson* (VSC, additional specimens to be distributed); Leland, NE of jct. Hwy. US 82 with California Ave., T18N R7W Sect. 22 NE/4, 12 May 1994, *Bryson 13437* (BRCH, BRIT, ctb, DSC, GH, IBE, KNK, MICH, MISS, MMNS, MO, NLU, NY, SWSL, TENN, USMH, VDB, VSC, WIS, additional specimens to be distributed); 29 May 1994, *Bryson 13918* (BRCH, BRIT, ctb, DSC, GA, GH, IBE, KNK, MICH, MISS, MMNS, MO, NY, SWSL, TENN, UARK, UNLV, USMH, VDB, VPI, VSC, WIS, additional specimens to be distributed).

Kyllinga brevifolioides (Delahoussaye & Thieret) Tucker was described based on specimens from Connecticut, North Carolina, Pennsylvania, and Virginia (Delahoussaye & Thieret 1967; Tucker 1984, 1987). Subsequently, *K. brevifolioides* has been reported from Maryland (Sipple 1978; Naczi et al. 1986), Tennessee (Kral 1981; Webb et al. 1981), Alabama and Georgia (Webb et al. 1981), New Jersey (Snyder 1983; 1984), Delaware (Naczi 1984; Naczi et al. 1986), Arkansas (Sundell & Thomas 1988), Mississippi (Bryson & Carter 1994), and Kentucky (Mears & Libby 1995). Like *K. brevifolia*, *K. brevifolioides* is an aggressive, troublesome perennial weed of lawns, turf, wet roadsides, ditches, cemeteries, and flowerbeds (Bryson & Carter 1994). Ferren & Schuyler (1980) and Webb & Dennis (1981) suggest that, like *K. brevifolia* and *K. odorata*, *K. brevifolioides* was possibly introduced from Asia. This collection reported herewith is the first report for

Monroe County in the Tennessee River Hills Region of Mississippi. This site is unique because *K. brevifolioides* grew on the bases and stumps of *Taxodium distichum* (L.) Rich. at or just above water and was associated with *Bidens discoidea* (Torr. & Gray) Britt., *Cyperus odoratus*, *Hypericum walteri* J.G. Gmel., and *Ludwigia leptocarpa* (Nutt.) Hara.

Voucher specimens: U.S.A. MISSISSIPPI. Monroe Co.: vicinity of Aberdeen, Aberdeen Lake Section of Tennessee-Tombigbee Waterway, T13S R7E Sect. 33 NW/4, 4 Nov 1995, MacDonald 9265, Warren, and Hartley (ctb, IBE, SWSL, VDB, VSC, additional specimens to be distributed).

Oxycaryum cubense (Poepp. & Kunth in Kunth) Lye {=*Scirpus cubensis* Poepp. & Kunth in Kunth, *O. schomburgkianum* Nees in Martius} is widely distributed, occurring in the West Indies (Kunth 1837), South and Central America (Nees von Esenbeck 1842; Adams 1994), the southeastern United States (Chapman 1889; Small 1933; Godfrey & Wooten 1979; Tucker 1987), and tropical Africa (Lye 1971; Haines & Lye 1983). In the southeastern United States, it is known from Florida (Chapman 1889; Wunderlin 1982; Clewell 1985), southern Alabama (Mohr 1901; Lelong 1988), Louisiana (Thomas & Allen 1993), and coastal Texas (Correll & Johnston 1970; Hatch, Gandhi & Brown 1990).

In habit and inflorescence morphology *O. cubense* resembles a *Cyperus*. It has spiral scale arrangement, a *Cyperus*-type embryo (van der Veken 1965; Lye 1971), and has been classified in both Cyperaceae (Lye 1971) and Scirpeae (Bruhl 1995). Inflorescence morphology varies in *O. cubense*, with specimens from peninsular Florida having umbellate inflorescences and those from Alabama, Louisiana, and Georgia consistently having capitate inflorescences. So far as we are able to determine, inflorescence form in *O. cubense* correlates with no other characters.

Oxycaryum cubense has been observed by Carter in peninsular Florida, southern Georgia, and southern Alabama, where it forms extensive floating mats in ponds, ditches, or impounded bayswamps. In Georgia and Alabama, *O. cubense* is apparently aggressive and invasive, forming monotypic floating batteries that may cover large areas of ponds to the exclusion of other aquatic plants. The following taxa were associated with *O. cubense* at the Baldwin County, Alabama, site: *Cyrilla racemiflora* L., *Hydrochloa caroliniensis* Beauv., *Liriodendron tulipifera* L., *Ludwigia* spp., *Hypericum* spp., *Magnolia virginiana* L., *Mayaca fluviatilis* Aubl., *Mikania scandens* (L. f.) Willd., *Myrica cerifera* L., *Nyssa biflora* Walt., *Salix nigra* Marsh., *Sambucus canadensis* L., *Sapium sebiferum* (L.) Roxb., *Typha latifolia* L., and *Utricularia* sp. At this site large specimens of *Nyssa biflora* in standing water were dying, indicating recent impoundment of the bayswamp or at least a recent increase in water-level, either, the likely result of beaver activity.

In Alabama, *O. cubense* was reported long ago from Mobile County (Chapman 1889, p. 660; Mohr 1901) and apparently was not seen again until 1976 when it was found in Baldwin County (Lelong 1988). Thus, the Alabama collection reported herein is apparently only the second collection from Alabama this century. The Georgia record cited below is the first from the state.

Voucher specimens. U.S.A. ALABAMA. Baldwin Co.: 0.17 mi W jct. Hwy. US 90 and county rd. 62, impounded bayswamp (beaver pond?) along N side Hwy. US 90, locally abundant, 10 Sep 1995, *Carter 12655* (ctb, SWSL, VDB, VSC). GEORGIA. Lowndes Co.: 5.3 miles E of Valdosta city center (courthouse), impounded bayswamp and ditch along N side Hwy. US 84, 26 Apr 1994, *Carter 11816* (ctb, SWSL, VDB, VSC); 18 May 1994, *Carter 11818* (ctb, SWSL, VDB, VSC); 9 Aug 1994, *Carter 11847* (ctb, SWSL, VDB, VSC).

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DOCUMENTED CHROMOSOME NUMBERS 1996:4. CHROMOSOME NUMBERS OF CAMPANULACEAE. IV. MISCELLANEOUS COUNTS

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ABSTRACT

Gametic chromosome numbers are reported for ten accessions of Campanulaceae, representing six genera and six species, one of which was represented by five cultivars. The chromosome number of *Cyanea hirtella* is reported for the first time; it has $n = 14$, the same as the four congeners previously reported. Within *Lobelia erinus*, a cultivar of the Pendula Group was tetraploid ($n = 14$), while four Compacta Group cultivars were hexaploid ($n = 21$). Previous counts of $n = 14$ in *Clermontia kakeana* and *Hippobroma longiflora*, $n = 16$ in *Campanula isophylla*, and $n = 17$ in *Trachelium coeruleum* were confirmed.

RESUMEN

Se citan los números cromosómicos gaméticos de diez recuentos de Campanulaceae, correspondientes a seis géneros y seis especies, una de las cuales está representada por cinco cultivares. Se recuenta por primera vez el número cromosómico de *Cyanea hirtella*; tiene $n = 14$, el mismo número que los cuatro congéneres previamente contados. En *Lobelia erinus*, un cultivar del grupo Pendula es tetraploide ($n = 14$), mientras que cuatro cultivares del grupo Compacta son hexaploides ($n = 21$). Se confirman los recuentos previos de $n = 14$ en *Clermontia kakeana* y *Hippobroma longiflora*, $n = 16$ en *Campanula isophylla*, y $n = 17$ en *Trachelium coeruleum*.

A comprehensive review and synthesis of data on chromosome numbers in Campanulaceae subfamily Lobelioideae was published recently (Lammers 1993). Since that summary, a few miscellaneous accessions have been counted. A parallel review of numbers in subfamily Campanuloideae is being prepared, and a few miscellaneous counts from that group likewise have accumulated, which require publication before they can be incorporated there. All of these counts are pulled together here and reported.

MATERIALS AND METHODS

The accessions of *Campanula*, *Lobelia*, and *Trachelium* examined in this study were cultivated by the senior author in the Chicago metropolitan area, while the material of *Clermontia*, *Cyanea*, and *Hippobroma* was collected from naturally occurring populations in the Hawaiian Islands. In both cases, flower buds were harvested and immediately fixed in a modi-

fied Carnoy's solution (6 chloroform : 3 ethanol : 1 glacial acetic acid, v/v) for a minimum period of 48 hours. For each sample, a voucher specimen was collected at the same time from plants of the same seed lot (cultivated plants) or from the same individual (naturally occurring plants) as the fixed floral buds. In the laboratory, anthers were excised from the buds and squashed in acetocarmine. Counts were then made from microsporocytes in various stages of meiosis via phase-contrast microscopy.

RESULTS

Chromosome numbers were successfully determined for ten accessions, representing six genera and six species, one of which was represented by five cultivars. These counts are summarized in Table 1.

DISCUSSION

This is the first report of chromosome number for *Cyanea hirtella*, the fifth of the 65 species in that endemic Hawaiian genus to be examined cytologically. All show $n = 14$, interpreted as tetraploid (Lammers 1993; Lammers & Lorence 1993).

African *Lobelia erinus* includes diploid ($n = 7$), tetraploid ($n = 14$), and hexaploid ($n = 21$) plants (Lammers 1993). All three levels have been reported in cultivated material, but only the first two have been found in natural populations. In Mozambique, Thulin (1983) reported a diploid count from coastal plants representing the segregate species *L. lavendulacea* Klotzsch, and a tetraploid count from plants at 1500 m elevation referable to the segregate species *L. senegalensis* A. DC. These are the only counts made from naturally occurring plants. All remaining counts in the literature were made from cultivated material.

Lobelia erinus is the most widely cultivated species of Lobelioideae in the world. Numerous cultivars are available, which may be classified into two groups: Compacta, with short erect stems and a strict habit, suitable for bedding and edging; and Pendula, with elongate decumbent stems and a lax habit, suitable for hanging baskets.

In this study, the single Pendula cultivar ('Rose Fountain') was tetraploid, while the Compacta cultivars ('Blue Moon', 'Blue Stone', 'Cambridge Blue', 'Paper Moon') were hexaploid. More extensive sampling will be required to determine if there is a correlation between ploidy level and growth form in this species. The earlier reports are not helpful in answering this question, because the cultivar or cultivar-group was not specified, or because the cultivars cited can not be equated confidently with modern cultivars. It is worth noting, however, that de Vilmorin and Simonet (1927) reported a hexaploid count for "var. *saphir pendula* hort.," which may refer to 'Sapphire', a cultivar of the Pendula Group.

TABLE 1. New reports of chromosome numbers in Campanulaceae.

Taxon	Voucher ^a	Locality ^b	<i>n</i>
<i>Campanula isophylla</i> Moretti cv. Stella White	8716	Cultivated	16 ^d
<i>Clermontia kakeana</i> Meyen	8128	O'ahu: Kamaile'unu Ridge, 775 m	14 ^d
<i>Cyanea hirtella</i> (H. Mann) Hillebrand	Wood 0903 (PTBG)	Kaua'i: Kalalau Rim, 1190 m	14 ^c
<i>Hippobroma longiflora</i> (L.) G. Don	8166	Kaua'i: 3 mi W of Hanalei, 20 m	14 ^d
<i>Lobelia erinus</i> L. cv. Blue Moon	8693	Cultivated	21 ^d
<i>Lobelia erinus</i> L. cv. Blue Stone	8692	Cultivated	21 ^d
<i>Lobelia erinus</i> L. cv. Cambridge Blue	8691	Cultivated	21 ^d
<i>Lobelia erinus</i> L. cv. Paper Moon	8694	Cultivated	21 ^d
<i>Lobelia erinus</i> L. cv. Rose Fountain	8584	Cultivated	14 ^d
<i>Trachelium coeruleum</i> L.	8713	Cultivated	17 ^d

^a Collection numbers without collector name or herbarium acronym were collected by Lammers and deposited at F.
^b "Cultivated" plants were grown from commercially obtained seeds in northeastern Illinois; the remaining localities are in the Hawaiian Islands.
^c First report for the species.
^d Confirms a previous report for the species.

The counts reported for the lobelioids *Clermontia kakeana* and *Hippobroma longiflora* confirm previously reported counts compiled by Lammers (1993). Similarly, the counts reported for the campanuloids *Campanula isophylla* and *Trachelium coeruleum* confirm previous reports of the same numbers. The former has been counted several times, most recently by Damboldt (1965); all reports show *n* = 16. The latter likewise has been counted several times, most recently by Contandriopoulos et al. (1984). Most of these reports show *n* = 17, though Contandriopoulos et al. (1984) found some plants with *n* = 16 in addition to 17-paired plants.

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NOTES

CAPRARIA MEXICANA (SCROPHULARIACEAE), AN
ENDANGERED ADDITION TO THE UNITED STATES FLORA

While surveying proposed drilling sites in Falcon State Recreation Area (Starr County, Texas, USA) on 7 February 1993, I found a shrub I could not identify. Other south Texas botanists consulted did not know it. Billie L. Turner identified it as *Capraria mexicana* Moric. ex Benth. (Scrophulariaceae), a species heretofore not reported from the United States.

A minimum of 66 mature *Capraria mexicana*, plus a number of seedlings, grew in three small stands in a reservoir-influenced habitat in a state park at the western edge of the lower Rio Grande Valley. The site lies near the inlet (or east) side of the low point between hilltops (one with screened shelters, the other with a recreation hall) making up a peninsula with Falcon Reservoir flooding the lower slopes. Elevation is about 305 feet. Extremely high reservoir levels may flood the site. Large, solid stands of spiny aster (*Erigeron ortegae* Blake) alternating with coastal bermuda (*Cynodon dactylon* (L.) Pers.), separate the *C. mexicana* known. Among the *C. mexicana* grows a carpet of coast germander (*Teucrium cubense* Jacq.), with a few granjeno (*Celtis pallida* Torr.) saplings and twinevines (*Sarcostemma cynanchoides* Dcne.). A few white-leafed Indian mallows (*Abutilon hypoleucum* Gray) and tree tobaccos (*Nicotiana glauca* Grah.) grow in the coastal bermuda.

Capraria mexicana grows along streams widely in Tamaulipas north to the San Fernando area. Billie L. Turner notes (pers. comm., 2 April 1993) that it "gets to about the upper 2/3 of Tamaulipas state." Bentham (1846) described the *C. mexicana* collected by Jean Louis Berlandier of Matamoros at Tampico, Tamaulipas and Greenman (1904) cited collection localities. Sprague (1921) revised the genus. No subsequent citations were found. *Capraria mexicana* ranges from Starr County, Texas at least to Tantoyuca, Veracruz (Tantoyuca is 105 km SW of Tampico). Intermediate localities (Sprague 1921) include Sota la Marina and Tampico, Tamaulipas. A provisional map provided by B.L. Turner (Fig. 1) shows the range of the species, based upon records at TEX and LL. Previous to this report, the northernmost record is Harde Le Sueuer's 1939 collection from the "shores of Laguna Anda la Piédra," near San Fernando, Tamaulipas.

The tallest of the much-branched shrubs bearing numerous flowers reach 2 m in height. Leaves linear-lanceolate, nearly sessile, acute leaves, serrate distally on mature shrubs, while remaining entire on seedlings; specimen leaves 2–5.5 cm long and 0.4–1 cm wide; older leaves shed, perhaps with increasing aridity; pedicels linear, axillary, ranging from 1 to 1.5 cm, shorter

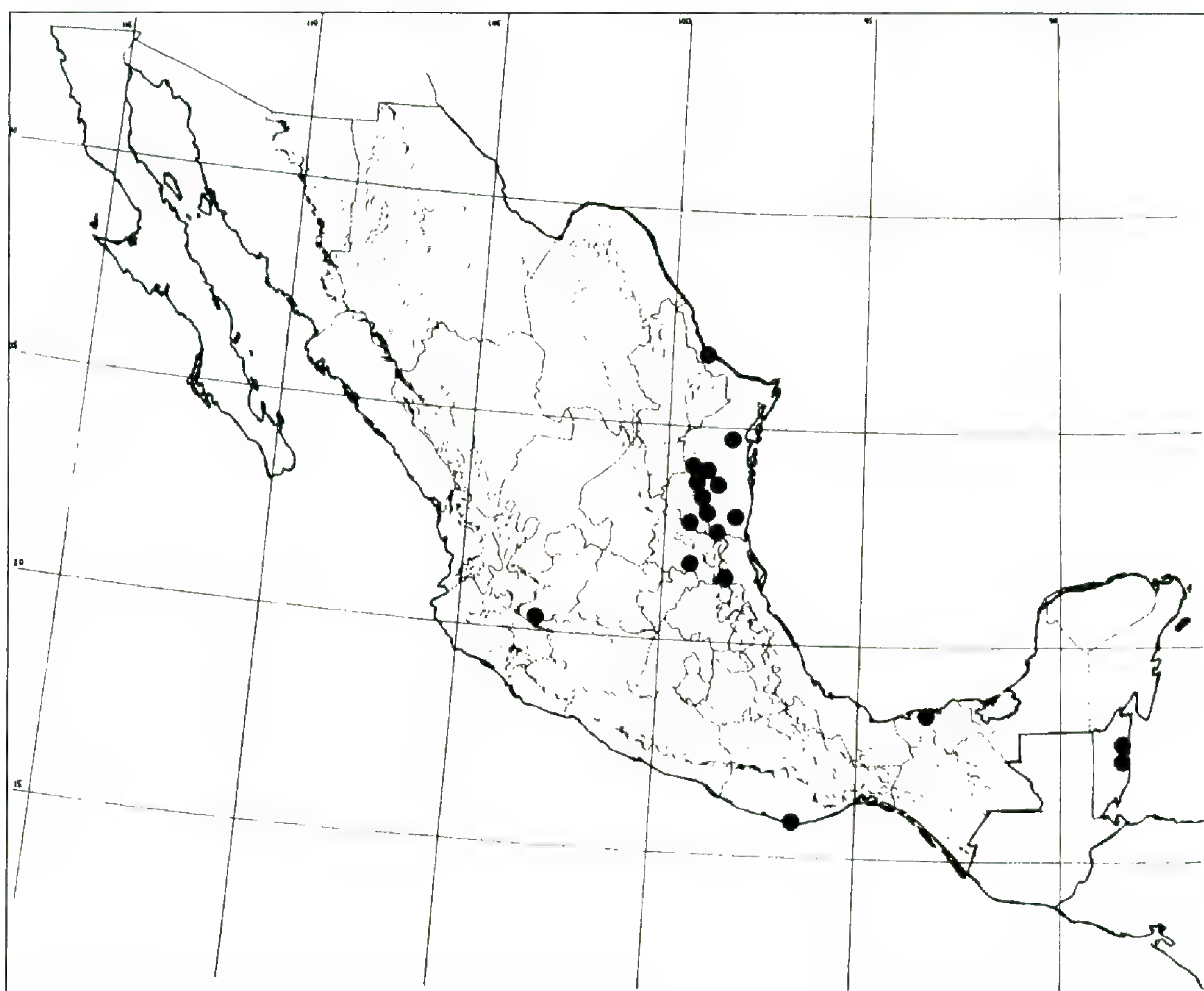


FIG. 1. Documented distribution of *Capraria mexicana*, based upon records at TEX and LL.

than subtending leaves; corolla white, greatly exceeding sepals; dry corollas measure about 8 mm, including lobes measuring 6 mm; corolla lobes lanceolate, acute, and twice as long as corolla tube; style exceeds stamen length, but less than corolla length, with one enlarged stigma; anther of each of five stamens bilobed basally; fully grown (green) capsules nearly twice the length of the (4)5 sepals (with calyx lobes shriveling as capsules mature and brown), 5–8 mm long and 3–4 mm thick, cylindrical, the two capsular lobes separated by a longitudinal septum and appearing to open near the distal (upper) ends and releasing numerous minute seeds. On 7 February, stems were leafed to the ground; on 28 February, many of the larger lower leaves had withered; on 14 April, the lower trunks were leafless. Flowers were observed from 7 February (numerous) to 14 April (few). In the similar *C. biflora*, corolla lobes are oblong, obtuse, and as long as or longer than the tube (Sprague's 1921 key). Justin Williams adds (pers. comm., 17 July 1995) that *C. mexicana* is glabrous and *C. biflora* is pubescent. [Description (other than corolla from key) stems from specimens examined and field observations in 1993 by the author.]

Despite the extensive medicinal literature on the allied *C. biflora* (Brenneker 1961; Cruz 1965; Diaz 1976; Edwin 1971; Eldridge 1975; García Rivas 1982; Hurtado 1894; Lavadores 1969; LeCointe 1947; Martinez 1969; Morton 1975; Morton 1977; Morton 1981; Nuñez-Melendez 1964; Roig y Mesa 1945; Souza-Novelo 1943; Standley 1930; Stehle & Stehle 1962; Wong 1976), I found no evidence that *C. mexicana* has been examined yet for medicinal components.

Capraria biflora is extensively used as a medicinal plant for a wide variety of ailments (references above), as an herbal tea (Morton 1981; Tanaka 1976), and in place of China tea (references in Sprague, 1921) from the Bahamas and south Florida across the West Indies into South America, north through Central America into northeastern Mexico. Its many English common names usually include a geographic name plus Tea and its Spanish, French and Portugese names frequently are direct translations. Since the species has been most commonly collected in the southern half of the Tamaulipan Biotic Province and since its congener is widely used as both medicinal and herbal tea, I propose using the common name of Tamaulipan Tea for *C. mexicana*.

The Texas Organization for Endangered Species listed *Capraria mexicana* as Endangered in Texas in 1993 (TOES 1993) and the Native Plant Project listed it as Endangered in the lower Rio Grande Valley of Texas in 1993 (NPP 1993). The species is not considered Endangered in Mexico. With the extremely low water levels in Falcon Reservoir and low rainfall in 1995 and early 1996, the plants suffer greatly from drought. A wind storm on 7 April 1993 snapped some *Capraria* branches and uprooted some Tree Tobaccos. In 1993 the park population escaped becoming part of a proposed drilling pad (Ideker 1993a,b).

I gratefully thank R.I. Lonard, M. Johnston, B.L. Turner, J. Poole, G.C. Janssen, J. Williams, M.D. Reed, and B. Lipscomb for discussion, identification, and/or review. Research and initial collection were made pursuant to State Park Scientific Study Permit #7-93 (and subsequent renewals) granted by D. Riskind. Initial collection sent to TEX.—Joe Ideker, Native Plant Project, P.O. Box 1433, Edinburg, TX 78540-1433, U.S.A.

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PERESKIA ACULEATA (CACTACEAE),
IN THE LOWER RIO GRANDE VALLEY OF TEXAS

On a 11 May 1996 field trip, a landowner told me he had cactus climbing into trees on a tract of land which had never been cleared. The site is 3.3 km northwest of Sebastian, Willacy County, Texas, U.S.A. The owner stated that the wooded tract and his residence had been in the family for many years and the cactus had not been planted. Nor did it grow around the residence. The tract is now surrounded by fields of Upland Cotton, *Gossypium hirsutum* L., and Grain Sorghum, *Sorghum bicolor* L. var. *durra* Hubbard & Rehd.

I found the hanging *Pisonia*-like leaves with little trouble. That is, the small spines found me several times as I searched until I found the wickedly-spined stems and areoles largely hidden in guinea grass (*Panicum maximum* Jacq.). The stems climb into trees, branch, and spread like vines. The leafy, distal ends with hooked spines hang down within two meters of the ground. William MacWhorter identified it as *Pereskia aculeata* Miller, lemonvine. Benson (1982) gives the range only as "Carribean Tropical Forest" and cites localities where the species has escaped cultivation in Florida. Britton and Rose (1963) give the range as the West Indies and Atlantic and Carribean Coasts of South America. Bravo Hollis (1937) indicates it is encountered in the wild in the littoral regions of the Gulf of Mexico.)

I assume these plants are naturalized from some former site now under the plow. The habitat is typical of riparian woodland dominated by sugar hackberry (*Celtis laevigata* Willd.) with a ground cover of guinea grass. This habitat may be a relict reflecting an ancient channel of the Rio Grande. The soil is Willacy fine sandy loam, 0 to 1% slopes (Turner et al. 1982). Where undisturbed, the natural ground cover is mostly subshrubs such as pigeonberry (*Rivina humilis* L.) and chaff-flower (*Achyranthes aspera* L.), and scattered clumps of rusty-seeded paspalum (*Paspalum langei* (Fourn.) Nash), manzanita (*Malpighia glabra* L.), and tropical sage (*Salvia coccinea* Buchoz ex Etlinger). A list of all species found on the tract appears in Ideker (1996).

Voucher specimens: *Pereskia aculeata*: TEXAS. Willacy Co.: 3.3 km NW of Sebastian, 11 May 1996, Ideker ABR11. *Achyranthes aspera*: TEXAS. Willacy Co.: 3.3 km NW of Sebastian, 11 May 1996, Ideker ABR05 (BRIT).

—Joe Ideker, Native Plant Project, P.O. Box 1433, Edinburg, TX 78540-1433, U.S.A.

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BOOK REVIEW

WILLIAM A. WEBER and RONALD C. WITTMANN. 1996. **Colorado Flora: Eastern Slope (Revised Edition)**. (ISBN 0-87081-387-0, pbk). University Press of Colorado, Niwot. \$29.95, xl + 524 pp. AND: WILLIAM A. WEBER and RONALD C. WITTMANN. 1996. **Colorado Flora: Western Slope (Revised Edition)**. (ISBN 0-87081-388-9, pbk). University Press of Colorado, Niwot. \$29.95, xxxvii + 496 pp.

William Weber is a veritable Roger Tory Peterson of Colorado Botany, given his fifty year output of user-friendly identification manuals and his concomitant influence in popularizing the identification of a regional biota. The nearly inevitable results of such guides are an increased awareness, appreciation of, and concern for the continued viability of local species. These recently published volumes are revisions of earlier works written by Weber alone (Weber 1987, 1990) and are of considerable merit. Given their striking similarity in overall format it seemed appropriate to review both simultaneously.

The volumes are remarkably similar to their predecessors (Weber 1987, 1990) and follow a sequence of Preface, Introduction, Key to Families, Ferns and Fern Allies, Gymnosperms, Angiosperms, Figures, Glossary, Index to Common Names, and Index to Scientific Names. The hydrologic Continental Divide separates the geographical ranges covered by these volumes. The Eastern Slope flora treats approximately 2300 species, whereas the Western Slope flora covers some 2100 species. Intraspecific taxa, not included in their floristic summaries, are included in the text.

The Preface in both manuals is nearly identical. Dr. Weber notes with satisfaction his own influence on the increased appreciation and study of botany in Colorado. His contributions are substantial, but the volumes lack acknowledgments and literature citations, and the section on eponymy by itself seems somewhat insufficient as a tribute to the work of earlier botanists. I am happy to see the authors flying a warning flag regarding the deleterious effects of invasives on native vegetation, an increasing worldwide problem and recent symposium topic in California. One major conduit for the spread of invasives not mentioned by the authors is the turning of the soil during the creation of fire lines in fire fighting efforts (Snow 1992–1994: 62), a factor that land management agencies may wish to add, however slightly, to their overall considerations of fire policy.

The Introductions are long. However, for those new to the joys of wildflowers and plant identification the Introductions provide a good summary of a wide body of information. Both volumes begin with "Scope of the Book" and "The Eastern [or Western] Slope", wherein physiognomic provinces are defined. For example, the Eastern Slope describes: The High Plains, North and South; The Mountain Front; The Intermountain "Parks"; North Park; South Park; The San Luis Valley; The Sawatch Range and Upper Arkansas Valley, and The Wet Mountain Valley and Spanish Peaks. These categories are followed by discussions of Floristic Zones, Plant Geography, Endangered Habitats, Rarity, Revegetation, Alien Plants, Some Floristic Statistics, How to Learn to Recognize the Big Families, Families with a unique character, Common Names, Pronunciation, Miscellaneous Notes, How to Collect and Preserve Botanical Specimens, The Importance of Voucher Specimens, Collecting Ethics, Plant Identification, How to Use the Keys, and "Eponymy. Botanists honored in Colorado Plant Names". The authors' attention to user-friendliness is evident in "How to Learn to Recognize the Big Families" and "Families with a Unique Character".

One oversight in "How to Collect and Preserve Botanical Specimens" was their neglecting to mention the now increasingly common use of Global Positioning Systems (GPS) systems to pinpoint collection localities on labels, and the importance such data will have for use with Geographical Information Systems (GIS).

Within each major category (Ferns and Fern Allies, Gymnosperms, etc.) the taxa are arranged alphabetically by family and by genera within families. The family and generic descriptions may include interesting information such as: hints for identification; geographical ranges; medicinal, ornamental, and folk uses; and, among other things, invitations to botanize!, like their suggesting where the rare *Cryptogramma stelleri* might be discovered (Eastern Slope volume). The species descriptions are brief and emphasize information relevant for diagnostic purposes. Taxonomic authorities, common names, and geographic ranges are included. I have not used the present volumes in the field, but based on personal experience during a ten year residence in the Rocky Mountain region, I found the Key to the Families of earlier editions easy to use.

Interspersed in the Eastern Slope are two sets of 32 color photographs, whereas the Western Slope has four sets of 16 photographs. The sets have no apparent taxonomic or other logical arrangement such as flower color (popular in some guides), but in most instances the photos are crisp. The Eastern slope text is followed by 103 black and white plates prepared by Ann Papageorge, Carolyn Ensle, and Harold Roberts, nearly all of which illustrate more than one species. The companion volume of the Western Slope has 107 plates (sixteen of which are the fourth set of color plates mentioned above).

The only obvious printing problems I spotted were large columnar gaps in the Index to Scientific Names (pp. 488, 492, 494) and fuzzy text (p. 471) in the Western Slope manual.

The biggest concern with these volumes, like their predecessors, is the extensive use of generic names unrecognizable to even well-trained students of the North American flora. The following examples probably ring few bells of recognition to most American plant systematists: *Sabina monosperma*, *Bolophyta alpina*, *Breea arvensis*, *Psychrophila leptosepala*, *Cylindropyrum cylindricum*, *Nuttallia decapetala*, or *Seriphidium tridentatum*. These are recognized by botanists as *Juniperus monosperma*, *Parthenium alpinum*, *Cirsium arvensis*, *Caltha leptosepala*, *Aegilops cylindricum*, *Mentzelia decapetala*, and *Artemisia tridentata*. As an example at the family level, the authors segregate Alsiniaceae from a larger and more inclusive Caryophyllaceae, which does not accord with other modern floristic (Larson 1986; Hartman 1993) or integrative family treatments (Cronquist 1981; Thorne 1992). These are but few of the many nomenclatural departures when compared with other North American treatments. To their credit, however, the authors indicate the more commonly used nomenclature in the text.

The lengthy exposition in an earlier edition regarding Weber's generic concepts has been removed from these volumes (Weber 1987: 9–13), but the effects of that philosophy are the primary basis for the large number of unfamiliar generic (and even family) names. Weber (1987: 12) once argued that "it is not necessary ... to produce detailed justification for adopting a particular taxonomic point of view (a name)". This statement suggests that the process of classification relies on (or did at one time) significant measures of experience and intuition. Today, classifications based even partly on intuition are much less tenable, and the creation of new names in the absence of new data has been criticized deservedly (Brown et al. 1993). It is true that Weber often has merely raised existing infrageneric taxon names up a notch or the generic level. However, a phylogenetic analysis is now seen by many (most?) practicing systematists as a necessary antecedent of revising classifications and invoking name changes, new or otherwise. Floras should largely reflect recent system-

atic revisions that are based squarely on sound data (see also Stevens 1990). This is a view that some taxonomists will still find uncomfortable, but it reflects what now appears to be a majority view. Unfortunately, the use of many of the generic names in these volumes has not been justified by recent monographic and/or phylogenetic work. On the other hand, I predict that at least some of the genera recognized by the authors ultimately will be upheld by phylogenetic work. If we cast concerns about nomenclature aside and look at the larger picture, however, we must be grateful for what we have: Modern and knowledgeable accounts of the higher vascular plants of Colorado, written by the person who knows them best. Residents of some other Western states are less fortunate, given the lack of up-to-date state Floras written by an expert with years of experience. I intend to buy my own copies, and suspect these volumes will be purchased and used by many others as well.

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CORRECTION

Figure 4, p. 26, Sida 17(1), Sep 1996. The caption in Figure 4, Bacon and Spellenberg, "Hybridization in *Quercus*" [Sida 17(1): 26] was inadvertently reversed in attempting to make a correction in final proof. The top figure, labelled "A" in the right margin is indeed *Q. eduardii*, not 4C as stated in the caption. The bottom figure, labelled "C" in the right margin is *Q. conzattii*, not 4A as stated in the caption. Sida and the authors apologize for this unfortunate error.

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TAXONOMY OF NORTH AMERICAN SPECIES OF *ZIZANIA* (POACEAE)

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ABSTRACT

The grass genus *Zizania* (Poaceae: Oryzeae) is defined to include four species, three of temperate North America and one of eastern Asia. Keys, descriptions, distributions, and synonymies are provided for the North American entities: *Z. aquatica*, *Z. palustris* and *Z. texana*. We discuss recent literature and the possible origin of *Z. palustris* var. *interior*.

RESUMEN

El género de gramíneas *Zizania* (Poaceae: Oryzeae) se define como un género con cuatro especies: tres de la parte templada de Norteamérica y una de Asia oriental. Se incluyen claves, descripciones, distribuciones y sinonimias para las entidades norteamericanas: *Z. aquatica*, *Z. palustris* y *Z. texana*. Examinamos la bibliografía reciente y el origen posible de *Z. palustris* var. *interior*.

The genus *Zizania* (Poaceae: Oryzeae: Zizaniinae) is defined here to include four species. Three are North American (*Z. aquatica* L., *Z. palustris* L., and *Z. texana* Hitchc.) and a fourth (*Z. latifolia* (Griseb.) Turcz. ex Stapf) is native to eastern Asia. *Zizania aquatica* and *Z. palustris* are important constituents of aquatic plant communities. The caryopses (grains) of *Z.*

palustris (northern wild-rice) are an important food being harvested in the wild and from cultivated paddies in Minnesota, California, Ontario and Saskatchewan. *Zizania aquatica* (southern wild-rice), native to the Atlantic and Gulf Coastal Plains, is not cultivated, but has been grown experimentally. *Zizania texana*, a local endemic in southcentral Texas, treated by Terrell et al. (1978), was included in experimental studies by Duvall (1987) and Duvall and Biesboer (1988a, 1989). We further understand that technical studies are being carried on by Francis Horne (pers. comm.) in San Marcos, Texas.

Basal parts of the culms and rhizomes of the Asian species, *Zizania latifolia*, are edible when infected with the fungus *Ustilago esculenta* Hennings (Terrell & Batra 1982). It is important to note that the presence of the fungus prevents flowering. Living material of *Z. latifolia* should be banned from importation into North America because infection of our native species might have serious ecological and economic consequences.

Hitchcock (1951; revised by Chase) referred to *Zizaniopsis miliacea* (Michx.) Doell & Aschers. as "southern wild-rice," implying close relationship to *Zizania*; however, *Zizaniopsis* and its related genus, *Luziola* (including *Hydrochloa*), are quite distinct in important reproductive characters from *Zizania* and were later placed in a separate subtribe (Terrell & Robinson 1974; Duvall et al. 1993).

This paper provides keys, descriptions, distributions and synonymies for the North American species of wild-rice. Representative specimens cited are primarily those in the US herbarium. Recent publications concerning the taxonomy of *Zizania* are discussed, with emphasis on *Zizania palustris* var. *interior*.

SYSTEMATIC TREATMENT

***Zizania* L., Sp. Pl. 2: 991. 1753 [& Gen. Pl. ed. 5. 427. 1754].** *Hydropyrum* Link, Hortus Berol. 1: 252. 1827, *nom. illeg.* *Ceratochaete* Lunell, Amer. Midl. Naturalist 4:214. 1915, *nom. illeg.* by lectotypification. LECTOTYPE: *Zizania aquatica* L. [Reveal, Phytologia 72:6. 1992].

Melinum Link, Handbuch 1:96. 1829, *nom. illeg.* (non Medikus, Philos. Bot. 2:40. 1791). TYPE: *Melinum palustre* (L.) Link [= *Zizania palustris* L.].

Monoecious aquatic annuals or perennials. Culms stout or slender, erect or decumbent. Leaves with sheaths open, rounded dorsally; ligules membranous or scarious, glabrous; blades flat, linear to broadly lanceolate, apices acuminate to caudate. Panicles terminal, in American species the staminate spikelets on lower branches, pistillate on upper branches, in the Asian species *Z. latifolia* both types on same branches. Spikelets 1-flowered, disarticulating from the expanded cupulate apices of pedicels, glumes absent, lemmas as long as spikelets, paleas subequal to lemmas, narrower. Stami-

nate spikelets pendulous, caducous, lemmas and paleas membranous, loosely covering the 6 stamens, lemmas usually 5-veined, paleas usually 3-veined; anthers 3–10 mm long in our species, linear, yellow. Pistillate spikelets cylindrical, caducous, lemmas and paleas chartaceous or coriaceous, plicately clasped along their margins, lemmas 5-veined, terminally awned, paleas 3-veined, awnless; stigmas 1–2.5 mm long in our species, short-plumose, at anthesis laterally exserted. Caryopses cylindrical, hilums linear, embryos linear.

From *zizanon*, an old Greek name for a weed growing in grain.

KEY TO NORTH AMERICAN *ZIZANIA* SPECIES

- 1. Plants perennial; culms geniculate, stoloniferous, completely immersed or only upper parts of culms emergent; upper ligules acuminate or caudate; restricted to San Marcos River, Hays Co., Texas 3. **Z. texana**
- 1. Plants annual; culms erect, not stoloniferous, rarely completely immersed; upper ligules often truncate or erose, occasionally acuminate; not along San Marcus River, Hays Co., Texas 2
- 2. Fertile (bearing mature spikelets) pistillate inflorescences 10–50 cm wide, with widely spreading branches (immature inflorescences or those bearing only aborted spikelets may have appressed branches); lemmas of pistillate spikelets chartaceous (papery) and flexible, dull or sublustrous, bearing scattered short prickly hairs not or only slightly denser at lemma apices, lemmas and paleas sometimes partly separating along their margins at maturity; aborted pistillate spikelets 0.4–1 mm wide, often thread-like; plants to 4 or 5 m tall; leaf blades (3–)10–72 mm or more wide 1. **Z. aquatica**
- 2. Fertile pistillate inflorescences 1–10(–50 in var. *interior*) cm wide, with all or most of the branches upwardly appressed or in var. *interior* somewhat spreading ; lemmas of pistillate spikelets coriaceous (firm and leathery) or indurate (hardened), lustrous, sometimes whitish, glabrous or with hairs in lines, the hairs often densely grouped at lemma apices, lemmas and paleas tightly clasped along their margins; aborted pistillate spikelets 0.6–2.6 mm wide; plants 1–2(–3 in var. *interior*) m tall; leaf blades 3–20(–40 in var. *interior*) mm wide 2. **Z. palustris**

1. ***Zizania aquatica* L., Sp. Pl. 2:991. 1753.**

Annuals with culms 0.2 to ca. 5 m tall, erect or decumbent, often stout, glabrous, most culms emergent or rarely immersed. Leaves with sheaths glabrous or scabridulous, margins ciliate or glabrous; ligules 5–30 mm long, upper ones ovate or triangular, truncate to acuminate, often erose or irregularly lobed; blades to 1.5 m or more long, (3–)10–55(–ca. 72) mm wide, scabrous or glabrate above and beneath, margins scabrous or glabrate. Panicles 20–120 cm long, (5–)10–50 cm wide; mature staminate branches ascending to widely spreading or reflexed, pedicel apices 0.2–0.6 mm wide; mature pistillate branches widely spreading or divaricate (sometimes appressed if immature or bearing only aborted spikelets), pedicel apices

0.5–1.2 mm wide. Staminate spikelets 5–12.5 mm long excluding awns, lemmas 1–2.5 mm wide, lanceolate, acuminate or with awns to 3 mm long, paleas with awns 0–2 mm long. Mature pistillate spikelets 5–24 mm long excluding awns, 1–2.5 mm wide, lemmas lanceolate or oblong, chartaceous, flexible, dull or somewhat lustrous, with numerous scattered short prickly hairs not or scarcely denser at lemma apices, mature lemmas and paleas often partly separating along margins, awns to ca 9 cm long, scabridulous; aborted pistillate spikelets 0.4–1 mm wide, linear, shriveled, often filiform. Caryopses 6–22 mm long, 0.8–2 mm wide. $2n=30$.

KEY TO THE VARIETIES OF *ZIZANIA AQUATICA*

1. Plants to 5 m tall; blades (5–)10–72 or more mm wide; pistillate spikelets 7–24 mm long; lemma awns to 90 mm long 1a. var. **aquatica**
1. Plants 0.2–1 m tall; blades 3–12(–20) mm wide; pistillate spikelets 5–11 mm long; lemma awns 1–8 mm long 1b. var. **brevis**

1a. *Zizania aquatica* L. var. *aquatica*. *Ceratochaete aquatica* (L.) Lunell, Amer. Midl. Naturalist 4:214. 1915. TYPE: without collector or data (LECTOTYPE: LINN 1119.1!; [Reveal, Phytologia 72:6. 1992]).

Zizania clavulosa Michx., Fl. Bor. Amer. 1:75. 1803. TYPE: North America: A. Michaux. *Hydropyrum esculentum* Link, Hort. Berol. 1:252. 1827. *Stipa angulata* L. ex Steud., Nomencl. Bot. ed. 2. 2:642. 1841, as syn. of *Hydropyrum esculentum* Link. TYPE: North America.

Zizania aquatica var. *subbrevis* B. Boivin, Naturaliste Canad. 94:528. 1967. TYPE: CANADA. ONTARIO: Russell Co.: Casselman, 21 Aug 1884, J.M. Macoun 28938 (HOLOTYPE: CAN).

Common name.—Southern wild-rice

Distribution.—In fresh or somewhat brackish marshes, swamps, rivers, streams, occasionally lakes. Coastal plain and locally in piedmont from New England and New Brunswick to Florida and west to southern Louisiana; from New England westward across southern Quebec and southern Ontario through the southern part of the Great Lakes region to central Ohio, northern Indiana and Illinois, southern 3/4 of Wisconsin, and rare in southern Minnesota; rare or absent in northeastern Iowa, western Kentucky and Missouri (Fig. 3). Occasionally introduced elsewhere for waterfowl food. A variant population in the Wading River area of southern New Jersey has narrow leaves and plants mostly immersed (Ferren & Good 1977; observed and collected in 1977 by Terrell and Ferren, and in 1983 by Duvall). Narrow-leaved populations occur locally in the New England states and near Ottawa, Ontario, and individual narrow-leaved plants occasionally occur elsewhere. Figs. 1, 3.

Selected representative specimens examined (US). CANADA. ONTARIO: Addington & Lennox Cos.: Napanee, along the Napanee River, 24 Jul 1952, *Dore* 13840. Carlton Co.: Marvelville, tributary of Castor River, 14 Sep 1973, *Dore & Carteret* 21157. Dundas Co.:

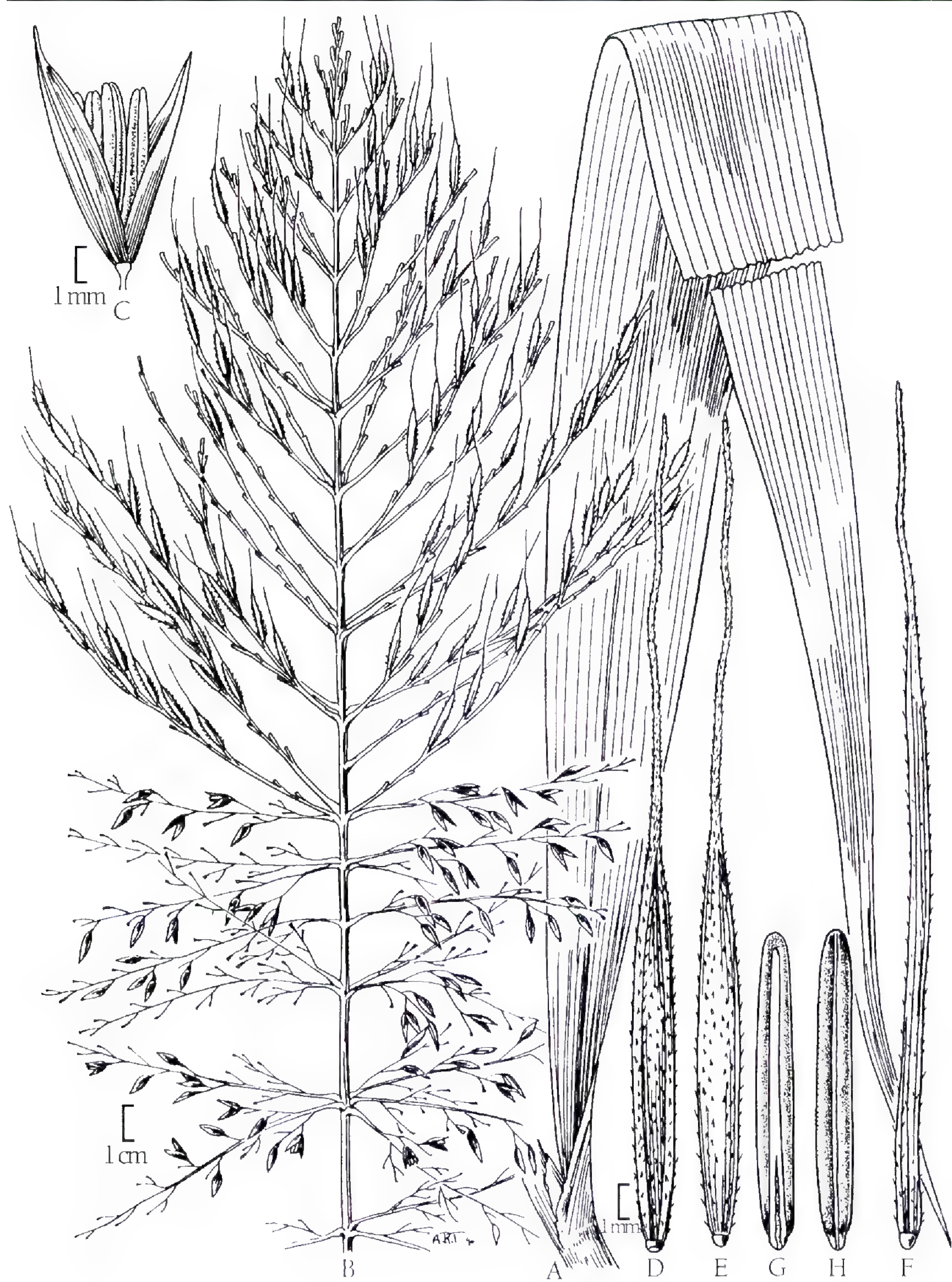


FIG. 1. *Zizania aquatica* var. *aquatica*. A. Culm leaf (Terrell 4467). Inflorescence (Terrell 4911). C. Staminate spikelet (Terrell 4459). D. Pistillate spikelet, ventral view (Terrell 4467, D-H). E. Pistillate spikelet, dorsal view. F. Aborted spikelet. G. Caryopsis showing embryo at base. H. Caryopsis showing hilum.

2 mi S of Marionville, Castor River, 14 Sep 1972, *Dore & Carteret* 25159. **Essex Co.:** Hillman, 19 Aug 1949, *Dore* 10340. **Frontenac Co.:** Verona, Hardwood Creek, 17 Aug 1951, *Dore & Mulligan* 13549. **Iberville Co.:** Henryville, South River, 12 Aug 1952, *Bassett & Hamel* 2454. **Leeds Co.:** 10 mi SW of Brockville, Jones Creek, 25 Sep 1950, *Dore* 12895. **Ontario Co.:** 3 mi E of Port Perry, Lake Scugog, 26 Aug 1949, *Dore, Senn, & Frankton* 10310. **Prescott Co.:** E of Alfred Station, Alfred Peat Bog, 12 Jul 1955, *Dore* 16000. **QUEBEC:** **Missisquoi Co.:** 2.5 mi N of Clarenceville, South River, 13 Aug 1952, *Bassett & Hamel* 2505.

UNITED STATES. **ALABAMA:** **Mobile Co.:** Mobile River, *Mohr s.n.* **DELAWARE:** **New Castle Co.:** Wilmington, 1 Sep 1897, *Commons s.n.* **Sussex Co.:** Nanticoke River at Woodland, 15 Sep 1976, *Terrell & Jones* 4559. **FLORIDA:** **Duval Co.:** Freshwater creeks, Oct, *Curtiss* 3364. **Marion Co.:** Dunnellen, Withlacoochee River, 9 Sep 1898, *Cambo* 906. **Orange Co.:** Cold Spring Creek, 23 Sep 1898, *Cambo & Baker* 1139. **Georgia:** **Bryan Co.:** Ogeechee River at bridge along Route 17, 7 Sep 1973, *Terrell* 4467. **Camden Co.:** White Oak Creek along Route 17, 8 Sep 1973, *Terrell* 4470. **Glynn Co.:** Altamaha River near Route 17, 8 Sep 1973, *Terrell* 4469. **McIntosh Co.:** Champney River along Route 17, 8 Sep 1973, *Terrell* 4468. **KENTUCKY:** Reelfoot Lake, 6 Oct 1915, *Alexander* 308. **LOUISIANA:** **Saint Tammany Par.:** vicinity of Covington, Sep 1919, *Arsene* 11596. **Maine:** **Barnstable Co.:** Harwich, Allen's Harbor Creek, 2 Sep 1918, *Fernald & Long* 16183. **MARYLAND:** **Anne Arundel Co.:** marsh along Patuxent River, 26 Aug 1973, *Terrell & Terrell* 4460. **Calvert Co.:** Chesapeake Beach, 18 Aug 1912, *Chase* 6132b. **Caroline Co.:** Denton, 6 Oct 1973, *Terrell & Terrell* 4476. **Dorchester Co.:** 1 mi NW of Sharptown, 15 Sep 1976, *Terrell & Jones* 4565. **Queen Anne's Co.:** Millington, 30 Sep 1973, *Terrell & Terrell* 4475. **MASSACHUSETTS:** **Middlesex Co.:** Cambridge, 26 Aug 1911, *Knowlton s.n.* **MICHIGAN:** **Berrien Co.:** New Buffalo, Margin of River, 20 Jul 1911, *Lansing* 3279. **Monroe Co.:** shores of Lake Erie, 27 Aug 1924, *Farwell* 7077. **Saint Clair Co.:** Port Huron, 12 Aug 1910, *Dodge* 12. **NEW JERSEY:** **Atlantic Co.:** 1-2 mi S of Green Bank along Route 563, 24 Sep 1977, *Terrell* 4911. **Burlington Co.:** Wading River just above Route 542, 21 Jul 1974, *Ferren & Good s.n.* **NORTH CAROLINA:** **Brunswick Co.:** 2 mi W of Wilmington, Brunswick River, 5 Sep 1973, *Terrell* 4462. **Chowan Co.:** Edenton, 20 Jul 1938, *Godfrey* 5337. **Jones Co.:** W of Pollocksville, Miry Hole Branch, 9 Sep 1966, *Bradley, Sears, & Bannister* 3467. **PENNSYLVANIA:** **Chester Co.:** West Chester, *Darlington s.n.* **SOUTH CAROLINA:** **Colleton Co.:** Combahee River at bridge on Route 17, 7 Sep 1973, *Terrell* 4465. **Jasper Co.:** 2 mi NE of Coosawhatchie, Tullipinny River, 7 Sep 1973, *Terrell* 4466. **Georgetown Co.:** Cat Island, 16 Aug 1915, *Alexander* 100. **RHODE ISLAND:** **Providence Co.:** Diamond Hill, 26 Sep 1942, *Palmer* 46579. **VIRGINIA:** **Charles City Co.:** Graves Landing, Chickahominy River, 10 Sep 1941, *Fernald & Long* 13537. **Fairfax Co.:** Hunting Creek, 20 Jul 1915, *McAttee* 2377. **Stafford Co.:** Potomac River at Aquia Creek, 28 Aug 1938, *Hermann* 9744. **WASHINGTON D.C.:** vicinis Washington D.C., 12 Sep 1880, *Ward s.n.* **Roosevelt Island,** 10 Oct 1958, *McClure s.n.* **WISCONSIN:** **Green Lake Co.:** Fox River, 2 mi W of Princeton, 23 Aug 1981, *Terrell* 5016. **LaCrosse Co.:** 4 mi E of LaCrosse, 22 Aug 1974, *Terrell* 4487.

1b. *Zizania aquatica* var. *brevis* Fassett, Rhodora 26:157. 1924. *Z. aquatica* subsp. *brevis* (Fassett) S. L. Chen, Proc. Int. Symp. Bot. Gard., Nanjing, China 600. 1990. TYPE: CANADA. QUEBEC: rocky tidal flats of St. Lawrence River, Levis, 9 Aug 1923, *H.K. Svenson & N.C. Fassett* 853 (HOLOTYPE: GH; fragment US 2797822!; photo Dore 1969: 18).

Common name.—Estuarine wild-rice.

Distribution.—Occurs only in tidal mud flats along the upper St. Lawrence River in Quebec about 80 km upstream and downstream from Quebec City. Fig. 3.

Representative specimens examined (US). CANADA. QUEBEC. Tidal flats, Neuville, 23 Aug 1947, *Swallen* 9703; just west of Pierre Laport Bridge, Anse Grigras, 13 Aug 1983, *Darbyshire* 2030. LEVIS Co.: S of ferry dock along St. Lawrence, 13 Aug 1983, *Darbyshire* 2031. LOTBINIERE Co.: Upper tidal flat of St. Lawrence estuary at Ste. Antoine des Fonds, 31 Aug 1947, *Dore* 47-971. PORTNEUF Co.: estuarine marsh of St. Lawrence, Portneuf, 9 Sep 1976, *Dore* 25522. QUEBEC Co.: upper tidal beach of estuary of St. Lawrence, Beauport Flats, 27 Aug 1975, *Dore* 25471.

2. *Zizania palustris* L., Mant. Pl. 2:295. 1771.

Annuals with culms to 2(–3 in var. *interior*) m tall, erect, glabrous, part or most of culms immersed. Leaf sheaths glabrous or with scattered hairs, margins glabrous; ligules 3–16 mm long, lanceolate to triangular, truncate or erose; blades 20–60 cm or more long, 3–20(–40 in var. *interior*) mm wide, glabrous, margins glabrate or scabrous. Panicles 24–60 cm long, to 20(–40 in var. *interior*) cm wide; mature staminate branches of panicle 3–20 cm long, branches ascending or spreading, pedicel apices 0.2–0.4 mm wide; mature pistillate branches of panicle 1–8(–15) (–50 in var. *interior*) cm long, appressed or ascending or 1–few branches spreading (to widely spreading in var. *interior*), pedicel apices 0.7–1.2 mm wide. Staminate spikelets 6–17 mm long excluding awns, lemmas 1–2.3 mm wide, lanceolate, acuminate or with awns to 2 mm long, paleas with awns 0–2 mm long. Mature pistillate spikelets 8–22(–33) mm long excluding awns, 1–2.6 mm wide, lemmas lanceolate or oblong, coriaceous or indurate, lustrous, sometimes whitish, glabrous or with short prickly hairs in lines, these hairs often more densely aggregated at lemma apices, mature lemmas and paleas remaining firmly clasped along their margins, awns to ca 9.3 cm long, hirsute at bases to scabrid distally; aborted pistillate spikelets 0.6–2.6 mm wide. Caryopses 6–30 mm long, 0.6–2 mm wide. $2n=30$. Fig. 2.

KEY TO THE VARIETIES OF *ZIZANIA PALUSTRIS*

1. Leaf blades 3–15(–20) mm wide; lower pistillate branches with 2–8 spikelets; pistillate inflorescences usually 1–10 cm wide, with appressed or ascending branches; plants to 2 m tall 2a. var. *palustris*
1. Leaf blades (10–)20–40 or more mm wide; lower pistillate branches with 9–30 spikelets; pistillate inflorescences (5–)10–50 cm wide, with branches ascending to widely spreading; plants 1–3 or more m tall 2b. var. *interior*

2a. *Zizania palustris* L. var. *palustris*. Mant. Pl. 2: 295. 1771. *Melinum palustre* (L.) Link, Handbuch 1:96. 1829. TYPE: garden plant grown at Uppsala (LECTOTYPE: LINN 1119.2!) [Reveal, Phytologia 72:7. 1992].

Z. aquatica var. *angustifolia* Hitchc., Rhodora 8:210. 1906. *Z. aquatica* subsp. *angustifolia*



FIG. 2. *Zizania palustris* var. *palustris*. A. Culm base (Terrell 4496). B. Inflorescence (Terrell 4515, B-G). C. Pistillate spikelet, ventral view. D. Pistillate spikelet, dorsal view. E. Aborted spikelet. F. Caryopsis showing hilum. G. Caryopsis, side view.

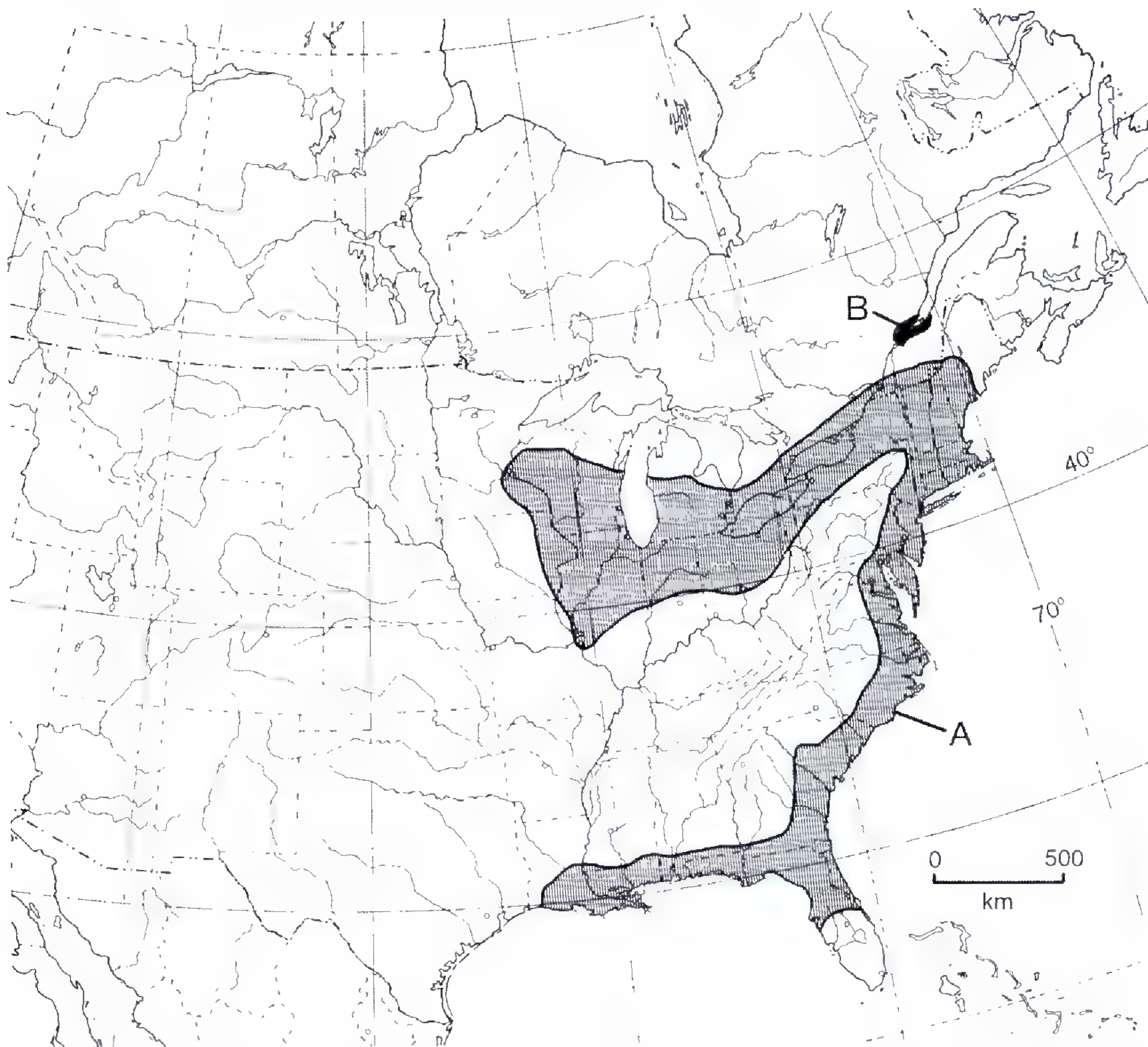


FIG. 3. Geographic distribution of *Zizania. aquatica* var. *aquatica* (A) and *Z. aquatica* var. *brevis* (B).

(Hitchc.) Tzvelev, Novosti Sist. Vyssh. Rast. 8:73. 1971. TYPE: U.S.A. MAINE: Belgrade, Aug 1895, *F. Lamson-Scribner* s.n. (HOLOTYPE: US 80339!)

Z. palustris forma *purpurea* Dore in McNeill & Dore, Naturaliste Canad. 103:565. 1976. TYPE: CANADA. ONTARIO: Russell Co.: in Castor River 2 mi E of Embrun, 21 Sep 1949, *W.G. Dore & R.J. Moore* 10587 (HOLOTYPE: DAO).

Common name.—Northern wild-rice

Distribution.—In shallow water of lakes and streams, often forming extensive stands in northern lakes; Nova Scotia (introduced), New Brunswick, southern Quebec, and New England states westward across the Great Lakes states, central and southern Ontario, to central Alberta (range extended westward by planting fide Aiken et al. 1988), the Dakotas, and Nebraska. Occasionally planted elsewhere for waterfowl food, known to have been introduced but probably not surviving locally in British Columbia, Arizona, West Virginia, and Idaho. Fig. 4.

Selected representative specimens examined (US). CANADA. MANITOBA: near Winnipeg,

30 Jul 1933, *Chambliss* 391. **NEW BRUNSWICK:** Westmoreland Co.: Aulac, Chignecto Isthmus Marsh, 21 Aug 1945, *Dore & Ingalls* 45-1068. **ONTARIO:** Hemlock Island, Georgian Bay Islands, 25 Jul 1942, *McDonald* 257. Roundtable Lake, Hardwick Township, 20 Aug 1951, *Garton* 1627. **Addington Co.:** 3 mi SW of Napanee, Napanee River, 16 Aug 1951, *Dore & Mulligan* 13540. **Carleton Co.:** Jock River, 11 Sep 1950, *Dore* 12850. **Frontenac Co.:** 8 mi SW of Arden, Salmon River, 14 Aug 1951, *Dore & Mulligan* 13417. **Leeds Co.:** 10 mi SW of Brockville, St. Lawrence River, 25 Sep 1950, *Dore* 12898. **Renfrew Co.:** Renfrew, Bonnechere River, 18 Aug 1952, *Cody & Parmelee* 6598. **Victoria Co.:** 2 mi E of Sebright, Head River, 20 Aug 1952, *Cody & Parmelee* 6682. **QUEBEC:** W of Lacolle, Lacolle Creek, 6 Aug 1952, *Dore & Cody* 13918. Noyan, Richelieu River, 6 Aug 1952, *Dore & Cody* 13919. **Chambly Co.:** Longueuil, 21 Sep 1924, *Victorin* 18258. **Labelle Co.:** Mont-Laurier, Petite River, 3-5 Aug 1941, *Marie-Victorin, Rolland-Germain & Blain* 1. **Nicolet Co.:** W of Becancour, St. Lawrence River, 11 Aug 1983, *Darbyshire* 2017.

UNITED STATES. INDIANA: LaGrange Co.: 2 mi E of Ontario, Pigeon River, 30 Aug 1914, *Deam* 15045. **Steuben Co.:** Lime Lake, 19 Aug 1916, *Deam* 20913. **White Co.:** 3 mi S of Buffalo, 24 Aug 1919, *Deam* 29542. **ILLINOIS:** Joliet, 22 Aug 1904, *Skeels* 462. **IOWA:** **Dickinson Co.:** Lower Gar Lake, 15 Aug 1957, *Thorne* 18599. **Fayette Co.:** 18 Jul 1894, *Fink* 180. **MAINE:** **Franklin Co.:** Farmington, Jul 1899, *Knowlton* 314. **Hancock Co.:** Long Island, Aug 1872, *Young s.n.* **Penobscot Co.:** Keg Stream, 28 Aug 1934, *Walker* 2032. **Sagadahoc Co.:** Bowdoinham, 14 Sep 1916, *Fernald & Long* 12580. **Washington Co.:** Princeton, 2 Sep 1932, *Chambliss* 248. **MASSACHUSETTS:** Concord, Sudbury River, 21 Aug 1904, *Worthen s.n.* **MICHIGAN:** **Allegan Co.:** Kalamazoo River above Allegan, 12 Sep 1902, *Wight* 124. **Emmet Co.:** Crooked river at Devil's Elbow, 9 Aug 1932, *Gates* 17206. **Huron Co.:** near Caseville, Saginaw Bay, 9 Sep 1910, *Dodge* 14. **Kalamazoo Co.:** SW of Vicksburg, Barton Lake, 21 Jul 1938, *Rapp* 2178. **Saint Clair Co.:** Lake Saint Clair, 12 Aug 1910, *Dodge* 13. **MINNESOTA:** **Cass Co.:** S of Deer River, Mississippi River, 31 Aug 1975, *Terrell* 4507. **Clearwater Co.:** Lake Itasca, 6 Aug 1929, *Grant* 3016. **Mille Lacs Co.:** near Mille Lacs Lake, 3 Sep 1975, *Terrell* 4515. **Otter Tail Co.:** East Battle Lake, Aug 1892, *Sheldon s.n.* **NEBRASKA:** Bone Creek, 29 Aug 1893, *Clements* 2921; near Halsey, 6 Aug 1934, *Martin* 439; Rat Lake, 14 Aug 1915, *Thomson* 51. **NEW YORK:** **Clinton Co.:** Plattsburg, Lake Champlain, 22 Aug 1917, *Hitchcock* 16018. **Jefferson Co.:** Woodville, along Lake Ontario, 23 Jun 1921, *House* 8217. **Oswego Co.:** Selkirk, Salmon River, 4 Aug, *Clausen & Hinkey* 4289. **St. Lawrence Co.:** Waddington, along the St. Lawrence, 22 Aug 1935, *House* 20744. **NORTH DAKOTA:** **Stutsman Co.:** Jamestown, James river, 22 Aug 1913, *Lunell s.n.* **SOUTH DAKOTA:** **Beadle Co.:** Huron, edge of James River, 23 Aug 1896, *Griffiths* 118. **Brookings Co.:** Brookings, Jul 1892, *Williams s.n.* **VERMONT:** West Haven, 18 Aug 1913, *Kirk* 1042. **WISCONSIN:** **Sawyer Co.:** Couderay Lake, 4 Aug 1930, *Williams* 68.

2b. *Zizania palustris* var. *interior* (Fassett) Dore, Publ. Dep. Agric. Canada 1393:20. 1969. *Z. aquatica* var. *interior* Fassett, *Rhodora* 26:158. 1924. *Z. interior* (Fassett) Rydb., *Brittonia* 1:82. 1931. *Z. palustris* subsp. *interior* (Fassett) S. L. Chen, Pro. Int. Symp. Bot. Gard., Nanjing, China 600. 1990. TYPE: U.S.A. IOWA: Emmet Co.: Armstrong, 27 Aug 1897, *L. H. Pammel & R. I. Cratty* 764 (HOLOTYPE: GH; ISOTYPE: US 328087!; photo Dore 1969: 19).

Common name.—Interior wild-rice

Distribution.—Sporadically in eastern Canada and westward across the Great Lakes region to southern Manitoba and central Alberta (range extended westward by planting; see Aiken et al. 1988), Nebraska, Kansas (?),

Minnesota, Iowa, Wisconsin, Missouri, and southward (by planting?) in Illinois, Indiana, and Ohio). Fig. 4, 5.

Selected representative specimens examined (US). CANADA. MANITOBA: Starbuck, 20 mi W of Winnipeg, La Salle River, 16 Aug 1950, *Dore* 12734. ONTARIO: Northumberland Co.: 3 mi W of Hastings, Rice Lake, 3 Sep 1952, *Dore & Hammond* 13981. Russell Co.: 3 mi W of Cumberland, Ottawa River, 18 Aug 1953, *Jenkins & Dore* 3532. QUEBEC: Chateaguay Co.: Chateaguay River, Aug 1941, *Boivin* 4425.

UNITED STATES. Illinois: Henderson Co.: near Oquawka, 1871, *Patterson s.n.* Madison Co.: Margins of lake, 8 Sep 1891, *Eggert* 286. Woodford Co.: N of Spring Bay, 12 Sep 1938, *Chase* 6181. INDIANA: Fulton Co.: 1 mi SE of Grass Creek, Grass Creek, 9 Aug 1928, *Deam* 46049. IOWA: Cook Co.: Desplaines River, 10 Aug 1901, *Chase* 1669. Hamilton Co.: 3 mi S of Jewell, Little Wall Lake, 16 Aug 1936, *Hayden* 10325. Linn Co.: Cedar Rapids, 20 Jul 1895, *B. Shimek* 68. MINNESOTA: Fort Snelling, Minnesota River, 28 Aug 1891, *Mearns* 776. Chippewa Co.: Montevideo, Chippewa River, 28 Jul 1895, *Moyer* 25. Itasca Co.: SE end of Bass Lake, 2 mi NNW of Cohasset, 31 Aug 1975, *Terrell* 4510. Pine Co.: 3 mi W of Pine City, 24 Aug 1974, *Terrell* 4491. Wabasha Co.: river along rt. 84, N of Weaver, 25 Aug 1981, *Terrell* 5020. NEBRASKA: Grant Co.: 15 mi S of Whitman, 3 Aug 1893, *Tulen* 1630. WISCONSIN: Buffalo Co.: slough in backwaters of Mississippi River, 1/2 mi SSW of Nelson, 4 Sep 1975, *Terrell* 4516. Trempealeau Co.: delta of Trempealeau River, Perrot State Park, 24 Aug 1981, *Terrell* 5017.

3. *Zizania texana* Hitchc., J. Wash. Acad. Sci. 23:454. 1933. TYPE: U.S.A.

TEXAS. Hays Co.: San Marcos River near San Marcos, Apr 1932, *W. A. Silveus* 518 (HOLOTYPE: US-1537174!; ISOTYPES: K! US-1720531!).

Perennial with culms 1–2(–5) m long, decumbent, geniculate, rooting at lower nodes, stoloniferous, long-streaming in river currents or the upper parts of culms emergent. Leaf sheaths glabrous; ligules 4–12 mm long, caudate or acuminate; blades to ca 1 m long, to 13(–25) mm wide, glabrous. Panicles 16–31 cm long, 1–10 cm wide; mature staminate branches ascending or somewhat spreading, pedicel apices ca 0.3 mm wide; mature pistillate branches appressed or ascending, pedicel apices 0.5–0.9 mm wide. Staminate spikelets 6.5–11 mm long excluding awns, lemmas 1.2–2 mm wide, ovate or oblong, acute to acuminate, paleas usually awnless. Mature pistillate spikelets 9–12.5 mm long excluding awns, 1.2–1.8 mm wide, lemmas lanceolate, somewhat coriaceous, somewhat lustrous, with scattered short prickly hairs, apices scabrous or hispidulous, awns 9–35 mm long, with scattered hairs; aborted pistillate spikelets 0.7–1.5 mm wide. Caryopses grown in cultivation 4.3–7.6 mm long, 1–1.5 mm wide, 1/2–3/4 as long as their lemmas. $2n=30$. See Fig. 814 in Hitchcock (1951).

Common name.—Texas wild-rice

Distribution.—This species is restricted to a 2.4 km length of the headwaters along the San Marcos River, within the city limits of San Marcos, Hays Co., in southcentral Texas (Terrell et al. 1978). The neutral or slightly alkaline (pH 6.9–7.8) water temperature varies only 5° (20.4–25.5) C annually. Officially listed as an endangered species.

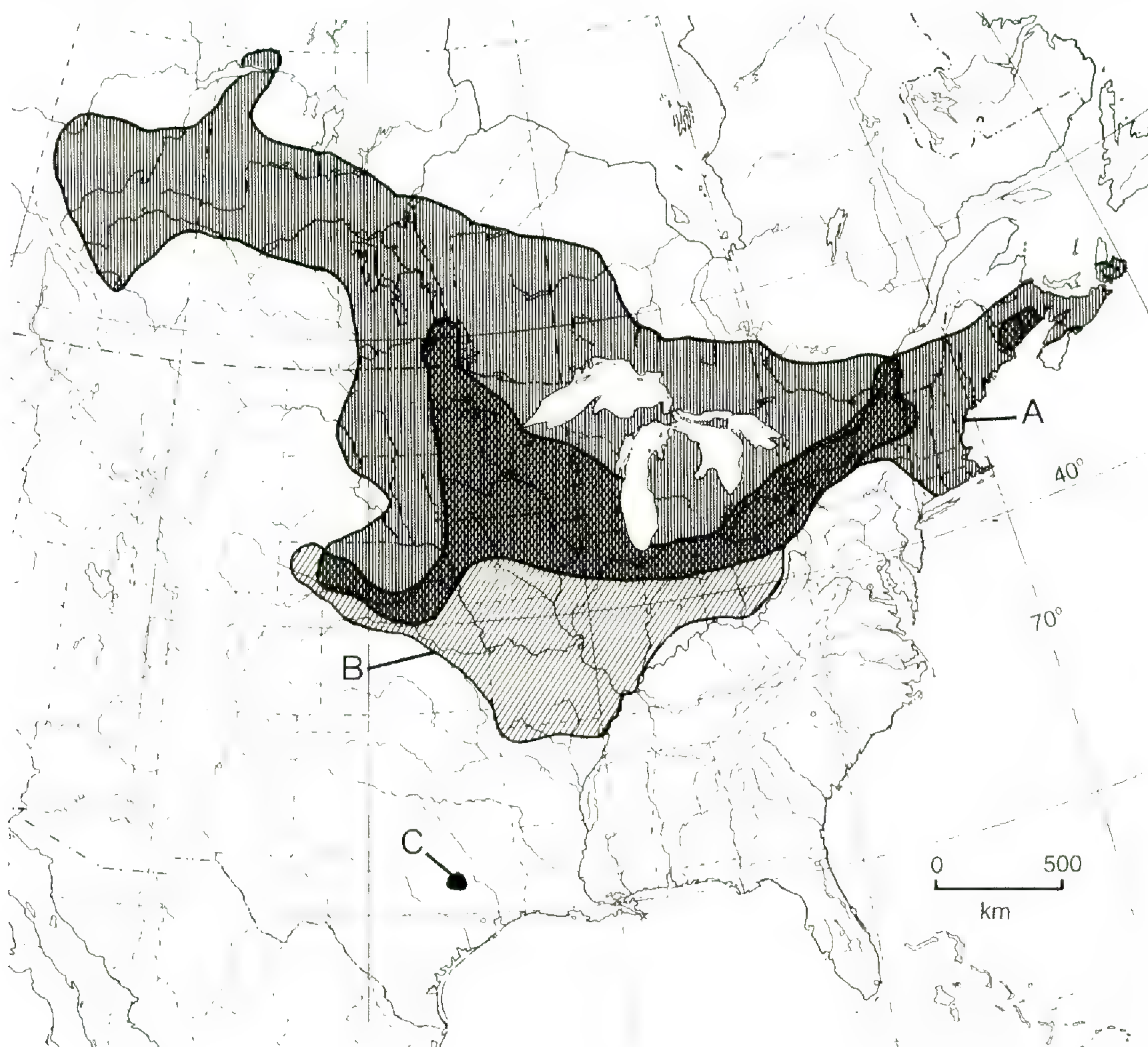


FIG. 4. Geographic distribution of *Zizania palustris* var. *palustris* (A), *Z. palustris* var. *interior* (B), and *Z. texana* (C). Central region shows overlap of A and B.

Representative specimens examined. UNITED STATES. TEXAS: Hays Co.: 1 mi below Spring Lake, San Marcos River, 14 Sep 1973, *Terrell, Emery & Beaty* 4472 (US); San Marcos, Aug 1892, *Nealley* 91 (MO, US); San Marcos, 6 Nov 1897, *Trelease* s.n. (BM, MO); "Marcos River," 31 May 1938, *Silveus* 2731 (BM); San Marcos River, 14 Jan 1936, *Hotchkiss* s.n. (BM, MO).

EXCLUDED NAMES

Zizania effusa Munro, J. Linn. Soc., Bot. 6:52. 1862, nom. nud. Munro alluded to a specimen of *Phragmites australis* (Cav.) Trin. ex Steudel (LINN, 1119.3!), annotated by J. E. Smith with this name.

Other excluded *Zizania* names were listed by Fassett (1924).

DISCUSSION

In the past *Zizania palustris* (or *Z. aquatica* var. *angustifolia*) was generally included in *Z. aquatica*, the older name, in most publications (e.g.,



FIG. 5. *Zizania palustris* var. *interior*. A. Culm leaf (Terrell 4516, A-D). B. Inflorescence. C. Pistillate spikelet, ventral view. D. Pistillate spikelet, dorsal view.

Fassett 1924). However, Wiegand and Eames (1925) listed both Linnaean species in their flora of the Cayuga Basin. Dore (1969) recognized the two species in his monograph of the Canadian wild-rices. The two distinct species are borne out by morphological data: They differ in size of the plants, in leaf width, in size and branching of the inflorescence, and the lemmas and paleas differ in texture and thickness, with prickle hairs differing in their arrangement (see key to species). The caryopses differ slightly in length and thickness, but measurements overlap (see photographs of caryopses in Dore (1969), Dore & McNeill (1980), and Aiken et al. (1988)). The two species also differ in ligule size and shape, but these differences can overlap. Terrell and Wergin (1981) found differences in the shapes of the silica bodies in the lemmas: *Z. aquatica* usually has C-shaped silica bodies, whereas *Z. palustris* has suborbicular silica bodies with 1–3 shallow sinuses.

Present data on distribution show that the two species have distinct but overlapping ranges (Figs. 3, 4) with *Zizania palustris* the wild-rice especially of northern lakes and *Z. aquatica* centered in the southeastern Atlantic and Gulf Coastal Plains.

The marked differences in the spikelets of *Zizania aquatica* and *Z. palustris* were well-known to Fassett (1924) and undoubtedly to others (see the early literature cited by Aiken et al. 1988). Duvall and Biesboer (1988a), found an anatomical basis for the textural differences in the lemmas and paleas, there being a single layer of thin-walled subepidermal fibers in *Z. aquatica*, whereas *Z. palustris* (with its coriaceous texture) has at least two layers of thick-walled fibers.

Warwick and Aiken (1986), in an electrophoretic study, concluded that genetic identity values between *Zizania aquatica* and *Z. palustris* were on levels expected for congeneric species. They did not find any isozyme evidence for gene flow between the two species. However, Duvall and Biesboer (1988b), in a study of artificial hybridization, found that hybrids were produced (at a low level) only when *Z. aquatica* was the female parent. These authors concluded that (1) the “near-unilateral crossability barrier” supported the taxonomic distinctness of the two species, and (2) the successful artificial hybridization (although limited) shows the potential for successful natural hybridization.

Zizania aquatica var. *brevis*, native to a portion of the St. Lawrence River, has been studied in detail by Darbyshire and Aiken (1986). Warwick and Aiken (1986) found no isozyme differences with *Z. aquatica* var. *aquatica*. Similarly, Duvall and Biesboer (1989) found no distinguishing seed storage protein differences between var. *aquatica* and var. *brevis*. These two varieties were also found to be fully interfertile under greenhouse conditions (Duvall & Biesboer 1988b), supporting their recognition as varieties rather than as species.

In 1924, Fassett described *Zizania aquatica* var. *interior*, which resembles *Z. aquatica* in leaf width and inflorescence characters, but *Z. palustris* in the characters of the pistillate spikelets. Dore (1969) transferred var. *interior* to *Z. palustris*, and in this we follow Dore. Like *Z. palustris*, plants of var. *interior* have been purposely introduced to wildlife refuges and private wildlife preserves; consequently, it is sometimes difficult to determine whether a population of Interior wild-rice occurred naturally or introduced. Aiken et al. (1988) maintained var. *interior* as distinct, but noted that it is sometimes difficult to separate var. *palustris* from var. *interior*, and on their map of *Z. palustris* in Canada they did not attempt to separate them.

Zizania palustris var. *interior* occurs mainly where the ranges of *Zizania aquatica* and *Z. palustris* overlap (Figs. 3, 4); consequently it has been hypothesized that var. *interior* includes hybrids (Dore and McNeill 1980). Herbarium specimens of var. *interior* are mostly concentrated in the central United States. Field studies by the senior author in 1974, 1975, and 1981 in the Mississippi Valley of western Wisconsin and southeastern Minnesota produced several collections of var. *interior*. Fassett (1927) saw it "growing abundantly along the Mississippi River from Lake Pepin to Fountain City"; certain of these specimens exist at WIS. One of the Terrell collections (4516 at US) included a range of morphological expressions varying from *aquatica*-like plants with broader leaves and more spreading pistillate branches to *palustris*-like plants with narrow leaves and compact appressed inflorescences (Fig. 5). These plants were like *Z. palustris* in spikelet morphology, thus agreeing with Fassett's (1924) original description of var. *interior*.

Cultivated strains of *Zizania palustris* have been selected by Minnesota growers for retention of mature spikelets to facilitate harvesting. In 1975, Terrell collected samples from several cultivars in Minnesota (vouchers at US). These were generally similar to *Z. palustris*, except in having some individuals bearing pistillate inflorescences with one or a few spreading or divergent branches, a condition called "crowfoot" by growers. Such plants are somewhat similar to *Z. aquatica*, which has spreading pistillate inflorescences. The electrophoretic study of Warwick and Aiken (1986) suggests that "Cultivated varieties, previously considered to be improved strains of *Z. palustris* var. *palustris*, were found to be more closely related to *Z. palustris* var. *interior* ..."

If var. *interior* is of hybrid origin we point out that the combination *Z. × interior* (Fassett) Rydberg (pro sp.) (Art. 50, Greuter et al. 1994; see also the present synonymy) is available for use. We also note that given not only the long expanse of evolutionary history but also the Pleistocene glaciations in particular it seems possible that var. *interior* could be the result of past introgressive hybridizations.

We emphasize, however, that some other evidence concerning var. *interior* argues against its origin as an interspecific hybrid. As noted above, Warwick and Aiken (1986) found no isozyme evidence of introgression between the annual species. A preliminary chloroplast DNA restriction sites study also failed to indicate that var. *interior* could be of hybrid origin (Duvall 1987). Even though an artificial hybridization study indicated that hybrids can be produced between the annual species, this study also showed virtually no difference in crossability between the two varieties of *Z. palustris* with those of *Z. aquatica* (Duvall & Biesboer 1988b). If var. *interior* were, in fact, of hybrid origin, one would expect it to (back) cross more readily with *Z. aquatica*, than does var. *palustris*. These data, coupled with the observation that all of the artificial F₁ hybrids that were produced in the hybridization study displayed the diagnostic spikelet characters of the *Z. aquatica* parent, is compelling evidence against the hypothesis of hybrid origin. These data suggested that vegetative similarities between *Z. palustris* var. *interior* and *Z. aquatica* var. *aquatica* are possibly an overlap of a morphological gradient of plastic and highly variable characters.

Unlike other North American *Zizania* species, *Zizania texana* behaved as a perennial in greenhouse experiments by Duvall (1987). A close relationship between *Z. aquatica* and *Z. texana* is supported by storage protein data (Duvall & Biesboer 1989) and distribution. However, crosses of *Z. texana* (ovulate parent) with three other taxa: *Z. aquatica* var. *aquatica*, *Z. palustris* var. *palustris*, and *Z. palustris* var. *interior*, resulted in hybrid progeny in only one case, that of *Z. texana* × *Z. palustris* var. *interior* (Duvall 1987). The pistillate spikelets of these hybrids were somewhat intermediate, unlike those of any other interspecific hybrid. Thus, full resolution of the relationships between annual and perennial species of North American wild-rice awaits further study.

ACKNOWLEDGMENTS

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BOOK REVIEW

CHEATHAM, SCOOTER and MARSHALL C. JOHNSTON with LYNN MARSHALL. 1995. **The Useful Wild Plants of Texas, the Southeastern United States, the Southern Plains, and Northern Mexico. Volume I. *Abronia* thru *Arundo*.** (ISBN 1- 887292-01-2, hbk). Useful Wild Plants, Inc., 2612 Sweeney Lane, Austin, TX 78723, U.S.A. \$125.00. xxi+ 568 pp. 304 color photos, 267 distribution maps.

This first of twelve volumes provides encyclopedic treatment of 78 genera and 267 species of native and wild growing plants of Texas and of botanically, read ecologically, related adjacent areas. Useful applies to a plants utility as food, natural products, medicine, fiber, landscape or aesthetic value, oil, folk use, etc. Each genus is treated alphabetically and includes a description of the 'group' and each taxon, botanical and common nomenclature, plant identification, habitat, a detailed rangewide distribution map, EXCELLENT color photograph(s), a broad category of uses as appropriate for the taxon, including ethnobiology, author experience by category of use, literature cited, index and more.

The treatments are well written and easy to read and understand. Marginal notes with keywords are provided for ease of location of subjects of particular interest. Unlike most encyclopedias, the overall design is aesthetically appealing and wholly supports the user friendliness of the volume.

Useful Wild Plants is the first fruit of a labor of love that spans at least two decades. According to the authors and publisher, six additional volumes are ready for press; but, with financial constraints only one or, hopefully two!, will be published per year. I, for one, am confident this daunting task will be accomplished.

Anyone interested in Texas' natural history, botany, ethnobiology, folk use of plants, conservation of Texas' natural heritage, natural plant products, traditional medicine, economic botany, plant propagation, or native plant landscaping will want to own this volume and those to come. This is a must have volume for every university and botanical library and certainly every major city or county library.

Useful Wild Plants is authoritative, comprehensive and thoroughly researched by an army of contributors, cooperators and volunteers. The distribution maps are, in my opinion, the best available for the treated species. The color photographs ARE the best.

In support of the production of the Useful Wild Plants of Texas encyclopedia, the authors have established a not-for profit corporation, Useful Wild Plants, Inc. Membership supports publication of the remaining volumes, includes the Useful Wild Plant Newsletter usually issued 'seasonally,' and entitles members to discounts on volumes to be published, and supports "Botany for the real World." Further information can be obtained from the publisher or from uwp@jumpnet.com. (See also Sida 16(3):609. 1995). — *David H. Riskind, Natural Resource Program, Texas Parks and Wildlife, 4200 Smith School Rd. Austin, TX 78744, U.S.A.*

PASSIFLORA CERASINA, A NEW SPECIES OF
PASSIFLORA SUBGENUS *PASSIFLORA*
(PASSIFLORACEAE) FROM FRENCH GUIANA

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ABSTRACT

Passiflora cerasina, sp. nov., is newly described and placed in *Passiflora* subgenus *Passiflora*. This species has been found in northeastern French Guiana on Montagne de Kaw, and in Surinam on Mt. Brownsberg. *Passiflora cerasina* belongs in the *P. laurifolia* group, more precisely among the few species that have the first row of corona filaments shorter than the second row.

RÉSUMÉ

Passiflora cerasina, esp. nouv., est décrite et placée dans *Passiflora* sous-genre *Passiflora*. Cette espèce a été trouvée dans le nord-est de la Guyane française sur la Montagne de Kaw, et au Surinam sur le Mont Brownsberg. *Passiflora cerasina* appartient au groupe de *P. laurifolia*, où elle est proche des espèces dont la couronne a les filaments du rang externe plus courts que ceux du second rang.

A new species *Passiflora cerasina* has been collected by the senior author on Montagne de Kaw (type) in the NE region of French Guiana. Montagne de Kaw (Kaw Mountain), French Guiana, is a narrow table mountain, with a lateritic crust on top. It is about 35 miles long and is a locality rich in species of *Passiflora* (Feuillet 1989, 1994), now with 19 known species. The new species has been discovered, though not collected, in Surinam on Mont Brownsberg at an elevation of about 500 m (30 Dec 1996).

Passiflora cerasina H. Annonay & C. Feuillet, sp. nov. (Fig. 1). TYPE: FRENCH GUIANA. Montagne de Kaw, road from Roura to Kaw, PK 6.3, 30 km SE of Cayenne, 4°60'N, 52°30'W, 75–100 m, 21 Apr 1997, H. Annonay 1 (HOLOTYPE: US).

Species haec in subgen. *Passiflora* pertinens; folia integerrima; stipulae linearia; bractaeae involucretae librae integrae foliaceae rubrae glandulosae; sepala et petala rubra; mesocarpium crassum, endocarpium rubrum, placentae candidae.

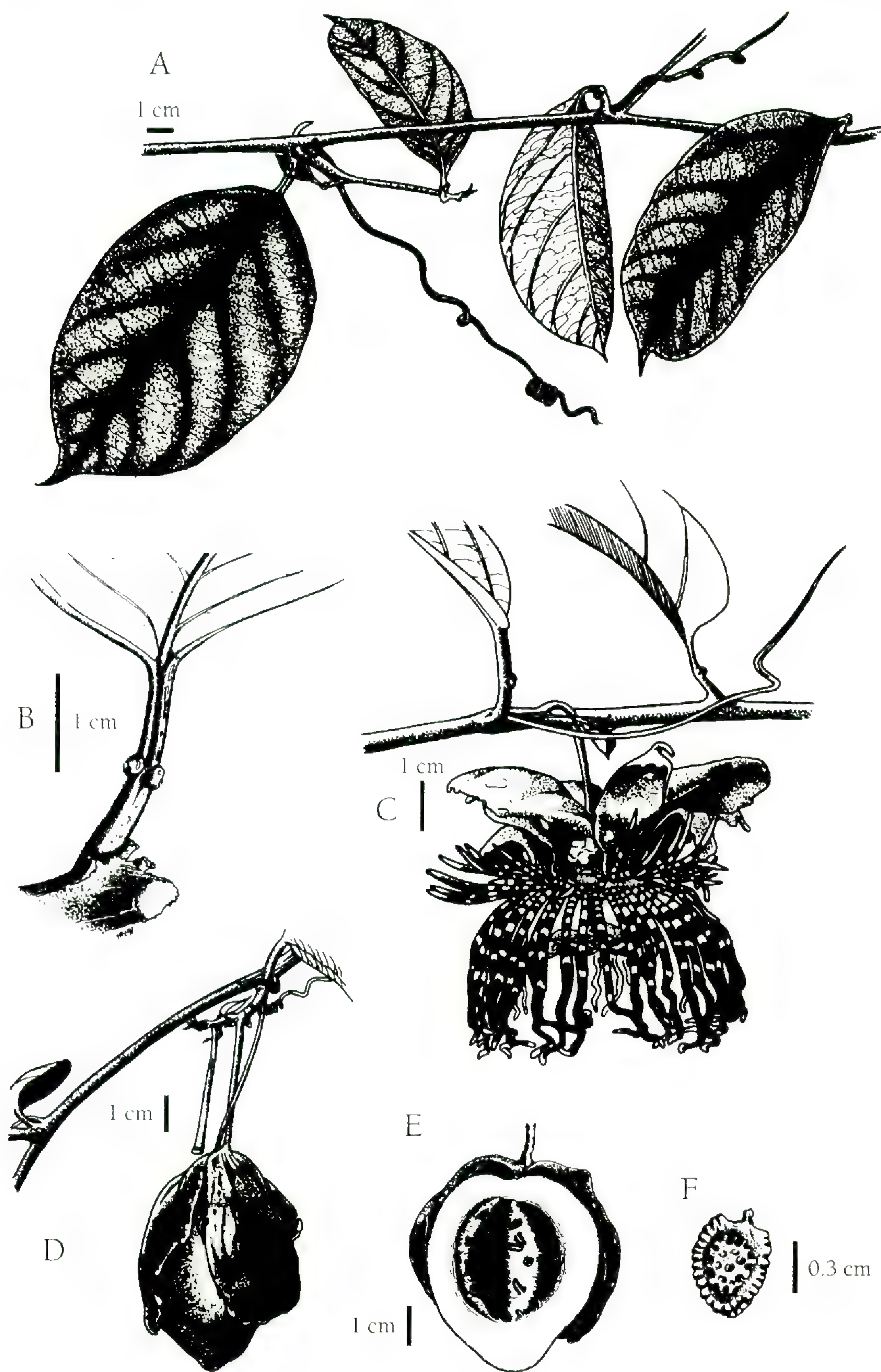


FIG. 1 — *Passiflora cerasina* Annonay & Feuillet, sp. nov.: a. Leaves. b. Petiole. c. Flower. d. Fruit. e. Longitudinal cut of the fruit. f. Seed. Scale: a–e. 1 cm. f. 0.3 cm (after the type).

Semiwoody climber with tendrils, glabrous throughout. Leaves simple, alternate; stipules linear, 3–5 mm long, pale green, early deciduous; petiole 2.0–2.2 cm long, canaliculate, bearing one pair of sessile glands near the middle, glands hemispherical-elongate, $2 \times 2 \times 2$ mm, green; lamina elliptic, $13\text{--}15 \times 8.0\text{--}8.5$ cm, upper surface dark green and shiny, margin entire, darker or somewhat reddish, rounded to cuneate at base, apex acuminate, acumen slightly curved, venation brachidodrome (looped), with 6–8 pairs of secondary veins, these prominent above and beneath, at lamina base the 1st pair marginal, the 2nd pair 3 mm from the margin, in the basal half of the lamina the minor lateral veins are perpendicular to the midrib. Flowers hanging, one per leaf axil, fragrant; peduncle ca. 2.2 cm long (elongating to about 5 cm in fruit), bearing three bracts; bracts ovate, verticillate, sessile, with marginal, yellow, sessile glands, $4.2\text{--}4.8 \times 2.2\text{--}2.9$ cm, apex rounded in flower, emarginate in fruit, cherry-red in flower, dark brownish violet speckled with dark green and with medium green margin in fruit; floral tube wider than long; sepals cherry-red, ca. $4 \times 0.8\text{--}1.2$ cm, bearing a curved, subterminal, yellowish awn, 0.7 cm long; petals cherry-red, ca. $4 \times 0.4\text{--}0.6$ cm wide; corona in several rows, the 2 outer rows of thick filaments, outermost row of filaments mostly white, with violet banding in the basal two thirds, curved upward, 2.0–2.5 cm long, the second outer row of filaments longer than the outermost row, 4.7–5.2 cm long, mostly violet with white banding in the basal half, curved downward forming a bell-shaped shade around the androgynophore, inner rows much shorter; stamen filaments flat, perpendicular to the androgynophore, yellowish white with light purple at apex, anthers dorsifixed, perpendicular to the filament and to the androgynophore, when the anther opens the whitish pollen is facing the throat of the floral tube (up on a hanging flower); ovary yellowish white, with 3 clavate apical styles, styles yellowish striped with light purple, stigmas whitish. Fruit obovoid, looking like a small quince, $4.5\text{--}5.0 \times 3.9\text{--}4.2$ cm, green with yellowish markings when unripe, dark purple densely freckled with pale green when ripe, soft due to a spongy mesocarp about 0.5–1 cm thick, endocarp cherry-red, the 3 placental zones white and bearing red ovules; seeds elliptic, coarsely reticulate, ca. 6×5 mm, nearly flat, 1.5 mm thick the middle, canaliculate at margin, each half crenate at margin, brown, in a white, juicy aril.

Distribution.—*Passiflora cerasina* is documented only by the type collected on Montagne de Kaw, in the slope forest at an elevation of 75–100 m. It has also been observed by the senior author on top of Mt. Brownsberg in Surinam at about 500 m elevation. *Passiflora cerasina* is the fifth species of the *P. laurifolia* group to be found on Montagne de Kaw. The other species from Montagne de Kaw are *P. laurifolia* L. and *P. nitida* Kunth with distribution areas much broader than the Guianas, and *P. crenata* Feuillet &

Cremers and *P. rufostipulata* Feuillet found only in NE French Guiana. In addition, *P. acuminata* DC., of the same group, has been seen between Cayenne and Montagne de Kaw by the junior author. With six out of 21 species of the *P. laurifolia* group being known from NE French Guiana, three of them only known from the area, the coastal table mountains of NE French Guiana are the probable center of diversification for this species group.

Systematics.—*Passiflora cerasina* belongs to *Passiflora* subg. *Passiflora* (lectotype: *P. incarnata* L.) and is part of what Killip (1938) called “ser. Laurifoliae” (nom. nud.: without type and without Latin description). It can be inserted into Killip’s key between *P. capparidifolia* Killip (sp. # 209) and *P. laurifolia* (#213), among species with the outermost row of corona filaments shorter than the second row. In this group, *Passiflora cerasina* is characterized by the combination of its floral color pattern, fruit shape, and endocarp color. Within this group it differs also from *P. capparidifolia* (# 209) and *P. popenovii* Killip (# 210) by its broadly elliptic leaves, from *P. nigradenia* Rusby (# 211) by its shorter peduncles and larger bracts and flowers, from *P. ambigua* Hemsl. (# 212) by the marginal glands on its bracts, from *P. laurifolia* (# 213) by its larger leaves with very different venation, and from *P. rufostipulata* (described recently) by its colored, concave bracts and by the shape and color of the stipules. As is common in the *P. laurifolia* group, the end of lateral branches tend to be hanging and look like inflorescences with reduced leaves and shortened internodes.

Etymology.—The epithet “cerasina” (= cherry red) refers to the color of the bracts, sepals, petals, endocarp, and ovules of the new species. The cherry red floral parts contrasting with the corona filaments banded white and purple-violet are reminiscent of the Peruvian *P. phoenicia* Lindley in the closely related *P. quadrangularis* group.

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CALCARATLOBELIA (CAMPANULACEAE): A NEW GENUS OF SPURRED LOBELIOIDS FROM MEXICO AND CENTRAL AMERICA

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ABSTRACT

The case is presented for the recognition of two genera of spurred lobelioids, *Heterotoma* and *Calcaratolobelia*, both presumably derived from the genus *Lobelia*. Formerly both genera were included in the genus *Heterotoma* Zucc. by most authors. Ayers (1990) concluded, however, that the spurred, blue- or pink-flowered lobelioids ought instead to be included within *Lobelia* section *Hemipogon* Benth. & Hook. A key and descriptions distinguishing the two spurred genera derived from the genus *Lobelia*, i.e. *Heterotoma* Zucc. and *Calcaratolobelia* Wilbur gen. nov., are provided together with the needed combinations with the synonymy of the twelve species and one variety that form the genus *Calcaratolobelia*: *C. aurita* (Brandege) Wilbur, *C. cordifolia* (Hook. & Arn.) Wilbur, *C. flexuosa* (C. Presl) Wilbur, *C. flexuosa* var. *intermedia* (Hemsley) Wilbur, *C. gibbosa* (S. Watson) Wilbur, *C. goldmanii* (Fern.) Wilbur, *C. knoblochii* (Ayers) Wilbur, *C. macrocentron* (Benth.) Wilbur, *C. mcvaughii* (Ayers) Wilbur, *C. margarita* (F. Wimmer) Wilbur, *C. pringlei* (B.L. Robinson) Wilbur, *C. tenella* (Turcz.) Wilbur, and *C. villaregalis* (Ayers) Wilbur. The synonymy of each taxa forming the genus *Heterotoma* is also provided.

RESUMEN

Se pretenden reconocer dos géneros lobeioides con flores espolonadas, *Heterotoma* y *Calcaratolobelia*, ambos probablemente derivados del género *Lobelia*. Anteriormente la mayoría de los autores incluían ambos géneros en *Heterotoma* Zucc. Ayers (1990) concluyó, sin embargo, que las lobeioides, de flores espolonadas azules o rosadas deberían incluirse en *Lobelia* sección *Hemipogon* Benth. & Hook. Se ofrecen una clave y descripciones para distinguir los dos géneros de flores espolonadas derivados del género *Lobelia*: *Heterotoma* Zucc. y *Calcaratolobelia* Wilbur gen. nov., junto con las combinaciones necesarias con las sinonimias de las doce especies y una variedad que forman el género *Calcaratolobelia*: *C. aurita* (Brandege) Wilbur, *C. cordifolia* (Hook. & Arn.) Wilbur, *C. flexuosa* (C. Presl) Wilbur, *C. flexuosa* var. *intermedia* (Hemsley) Wilbur, *C. gibbosa* (S. Watson) Wilbur, *C. goldmanii* (Fern.) Wilbur, *C. knoblochii* (Ayers) Wilbur, *C. macrocentron* (Benth.) Wilbur, *C. mcvaughii* (Ayers) Wilbur, *C. margarita* (F. Wimmer) Wilbur, *C. pringlei* (B.L. Robinson) Wilbur, *C. tenella* (Turcz.) Wilbur, y *C. villaregalis* (Ayers) Wilbur. También se ofrece la sinonimia de los taxa que forman el género *Heterotoma*.

My introduction to the lobelioid genus *Heterotoma* (Campanulaceae: Lobelioideae) was in the early spring of 1948. It was in the old National Herbarium of Mexico then located in Chapultepec Park in Mexico City.

Rogers McVaugh, whose assistant I had the great good fortune to be on his first trip to Mexico, was paying a courtesy call on its then Director, Maximiliano Martínez. Dr. Martínez, whose English was said to be excellent, kept that fact from us. Dr. McVaugh spent a difficult afternoon of one day and the morning of another struggling to express himself in Spanish with very little help and no evidence of sympathy from Dr. Martínez. I soon escaped the linguistic ordeal by wandering off to browse in the herbarium. Afterwards I commented on the extreme heterogeneity of *Heterotoma* as clearly demonstrated by the collections. Dr. McVaugh indicated that the genus was not very natural, in that one species, *H. lobelioides*, seemed to be derived from the genus *Lobelia* in the vicinity of *Lobelia laxiflora*, and the small-, and blue-flowered species of *Heterotoma* more closely resembled the numerous blue-flowered *Lobelias*. The hypanthial spur was the principal feature binding together the disparate species composing *Heterotoma*. McVaugh commented that this was not an ideal example of a natural genus but perhaps it was the best that could be done with what was in all probability merely "a genus of convenience." This appraisal was later reaffirmed by him (1965), noting that taxonomy would not "be well served" by the addition to *Heterotoma*, of a very different spurred species of *Lobelia* from Colombia. Pragmatic treatments such as this may have served us well in mid-century and for a few decades thereafter, but their chances for continued unchallenged acceptance in the age of cladism is slight.

McVaugh's (1940) study of the problems of generic recognition within the lobelioids led him to the following generalizations:

"It appears, then, that almost any attempt at a natural classification of the Lobelioideae must strike a balance among the following courses: (1) Define a considerable number of small genera, each fairly uniform in character, but set off from closely related groups by purely arbitrary characters. This course involves the creation of a number of new names. (2) Make generic limits ample enough to allow for the inclusion of most of the anomalous species. This will tend to make the genera larger and fewer, and will also necessitate the creation of many new names. (3) Make the genera as small and homogeneous as is compatible with logic, at the same time recognizing the weight of convention as it bears on the subject of generic limits. It seems to me [i.e., McVaugh] that best results may be obtained from this last course, if at the same time it be remembered that the 'genus', as ordinarily defined, is a conventional concept; it is less a natural unit than the species and more to be thought of as a means of classification. Convenience, therefore must be taken into account as well as apparent kinship between species or groups."

Ayers (1990), having investigated the species comprised in the traditional genus *Heterotoma* and its presumed closest relatives, concluded that

her admittedly “abbreviated study ... supports the hypothesis of parallel evolution of nectar spurs in at least two separate lineages within the Mexican and Central American members of *Lobelia*” and “makes the recognition of the polyphyletic genus *Heterotoma* untenable”

Some may recall the “good old days” when Simpson’s definition (1961, p.124) that monophyly “is the derivation of a taxon through one or more lineages ... from one immediately ancestral taxon of the same or lower rank,” was thought adequate. Under such a concept of monophyly, it would seem that even *Heterotoma* in the traditional sense would be considered monophyletic, because the red and yellow, large-flowered *Heterotoma lobelioides* is suspected of having been derived from *Lobelia* section *Homochilus* A.DC., while the pink, white or bluish, small-flowered species may well have evolved from *Lobelia* section *Hemipogon* Benth. & Hook. f. In this event, the genus *Heterotoma* in its entirety would be thought to have evolved from the genus *Lobelia*, an ancestral taxon of the same rank. This of course is contrary to Hennigian principles since the “stem” *Heterotoma* is by inference a *Lobelia*.

Although not convinced that *Heterotoma* in the sense of McVaugh (1943) and Wimmer (1953) and other pre-Hennigian authors has been demonstrated to be unacceptably “polyphyletic” as claimed by Ayers, at least as the term was used in the first half of the century, it must be conceded that times have changed and that a stricter and narrower interpretation is now the prevailing practice in delimiting genera. If *Heterotoma*, in the restrictive sense of the original publication and of Ayers’ (1990) conclusion, is deemed worthy of generic status, at least until further studies are completed, it would seem that the spurred, small-flowered derivatives of *Lobelia* are equally deserving of generic recognition.

Ayers concluded emphatically that the generic independence of *Heterotoma s.l.* (including both the red-yellow flowered species (*H. lobelioides*) and the blue-flowered species) was unacceptable. Ayers stated that there were three acceptable alternatives to the scheme she favored.

- 1) Place all species of *Heterotoma* in the appropriate sections of the *Lobelia* from which they apparently evolved i.e. place the blue or pink flowered species in *Lobelia* sect. *Hemipogon* and the red & yellow, long-spurred species in *Lobelia* section *Homochilus*.
- 2) Retain *Heterotoma lobelioides* as a separate monotypic genus and recognize the two groups of small-flowered species as members of the paraphyletic genus *Lobelia*.
- 3) Recognize a monotypic *Heterotoma lobelioides* with its two varieties and establish a new genus for the two small-flowered species groups, *Macrocentron* and *Cordifolia*.
- 4) Transfer *Lobelia margarita* to a newly erected genus containing the members of *Heterotoma*, excluding *H. lobelioides*.

Ayers considered the fourth alternative acceptable only if evidence in addition to the presence of floral spurs could be found relating *Heterotoma pringlei* and the very similar, pouched but non-spurred *Lobelia margarita* to the small-spurred taxa. It would seem to me that if Ayers' investigation demonstrated anything convincingly it was that *margarita* and *pringlei* are closely related.

The establishment of a new genus for the small-spurred, blue-flowered species, although admittedly theoretically justifiable, was not favored by Ayers, fearing the proliferation of small, even though monophyletic, genera. Ayers favored the second of the listed options even though her solution continued recognition of a paraphyletic *Lobelia*. Because she could not demonstrate that *Lobelia laxiflora* is a sister "group" to the small, blue-flowered herbaceous species of *Lobelia*, Ayers concluded that it would be premature to transfer *Heterotoma lobelioides* into *Lobelia* section *Homochilus* since such a change might prove superfluous after the "final" analysis of *Lobelia* is completed.

My sense of logical order within the spurred lobelioids leads me to favor the fourth alternative listed by Ayers: namely the recognition of *Heterotoma* as one genus probably derived from *Lobelia* in the vicinity of section *Homochilus* A.DC. and the establishment of a new genus for the bluish or pink-flowered spurred (or at least pouched) species apparently also derived from *Lobelia* but from section *Hemipogon* Benth. & Hook. f.. Cladists will condemn both Ayers' arrangement and mine. The genus *Lobelia* is admittedly rendered paraphyletic in Ayers treatment; cladistically my arrangement is even less tolerable since in all likelihood both *Heteropogon* and *Calcaratolobelia* are derived from different sections of *Lobelia* and hence *Lobelia* is in all likelihood twice paraphyletic. (Perhaps one should leave well enough alone, but surely more trouble is in the offing for *Lobelia* and the stability of classification in the Lobelioideae. There would seem to be no possibility of maintaining *Diastatea* Scheidw. as a genus distinct from *Lobelia* if the same criteria are applied to it as have been to the small-spurred species here referred to *Calcaratolobelia*.)

McVaugh (1945, p. 15–17) presented a series of eight recommendations to serve as a formal set of generic criteria for the Campanulinae, with which he was then primarily concerned, but which have proved helpful in other families. Two of his recommendations perhaps offer guidance (and support) for the course of action taken here:

"Recommendation 3 ... Genera of the nature of satellites, if also comprising two or more series of species, invite suspicion especially if united by a single character which is also the only character separating them from a more inclusive genus."

This recommendation would argue against the recognition of *Heterotoma* s.l. since it comprised two or more series of species, the red and yellow, large flowered *H. lobelioides* and the blue and white or pink, small-flowered

species as both series are united by a single character (i.e. the nectariferous spur) which is “also the only character separating them from a more inclusive genus” [i.e., *Lobelia*].

Recommendation 6. “Any segregate genus should be sharply delimited; that is, any species which is *intermediate* in one or more respects towards a more inclusive genus should be relegated to the latter. The retention of the anomalous species in the more inclusive genus will change its limits, if at all, but very slightly, and only in this way can the segregate genus be precisely defined.”

This recommendation would support Wimmer’s original placement of *Heterotoma pringlei* (= *Lobelia gypsophila* Ayers) in the genus *Heterotoma* rather than in *Lobelia*, where Ayers placed it, but to say this is not fair to Ayers for she placed all of the bluish or pinkish to white-flowered species in the genus *Lobelia*. It was her firm conviction that the spurred *Heterotoma pringlei* is not only a *Lobelia* but that it is more closely related to the pouched but non-spurred *Lobelia margarita* than it is to any of the other bluish or pinkish, small-flowered, spurred species as shown by its gypsophilous soil preference, pedicellary movements during fruit maturation, similar and unique pollen exine, and similar, somewhat smaller, unusually colored seeds. Acknowledging the close relationship between *Heterotoma pringlei* (= *Lobelia gypsophila*) and *Lobelia margarita* as demonstrated by the shared features listed above, it would seem best to place the two species in one genus. Ayers concluded “that despite the difference in hypanthial morphology, they should not be placed in separate genera” and the genus to which both were assigned by her was *Lobelia*.

In contrast I place both of these species (i.e. the species that Ayers refers to as *Lobelia margarita* F.E. Wimmer and *Lobelia gypsophila* Ayers (= *Heterotoma pringlei* B.L. Robinson) together with both groups of spurred “lobelioids” that Ayers designated as the “*cordifolia* species groups” and the “*macrocentron* species group” into the same new genus here designated as *Calcaratolobelia*. These three species groups can be separated by the following key.

1. Decumbent or procumbent perennial herbs spreading from underground rhizomes; pedicels erect and stationary during fruit maturation; corolla pinkish purple A) the **Macrocentron** species group.
1. Erect annual herbs or tap-rooted perennials; capsule reoriented during fruit maturation by movement of the pedicel; corollas blue, pale lavender or white or rarely pink-purple.
 2. Tap-rooted perennials; pedicels divergent at 90° angles, in fruit deflexing abruptly at the hypanthium and reorienting the capsule, with spur or pouchside down and nearest the stem axis B) the **Gypsophila** species group.
 2. Fibrous-rooted or tap-rooted annuals; pedicels arcuate at 45° angles, in fruit reflexing abruptly at the hypanthium and reorienting the capsule, with the spur-side nearest the stem axis C) the **Cordifolia** species group.

This is Ayers' fourth alternative treatment of the possible relationships of the components of *Heterotoma s.l.* and their presumed ancestral groups within *Lobelia*. She did not favor this alternative until additional evidence besides the presence of floral spurs was found relating "*Heterotoma pringlei* (and thus *L. margarita*) to the other small-spurred taxa."

It is disconcerting that one is now placed in such a defensive position by recognizing segregate genera such as *Heterotoma* and *Calcaratolobelia*. Such segregates clearly render the very large genus *Lobelia* paraphyletic and therefore are unacceptable to a great many cladistically indoctrinated systematists. Brummitt (1996), in a most interesting defense of the unavoidability of paraphyletic taxa, urges us "not to be ashamed of paraphyletic taxa" as they are and have been "an unavoidable and essential feature of our taxonomy." Clearly, if the orthodox cladists are correct, we systematists have barely begun our tasks for an alarming percentage of genera and families currently recognized are paraphyletic (Funk 1985; Judd et al. 1994). If one's taxonomy admits that the evolutionary process has produced the incredible diversity which we attempt to classify, then it seems inevitable that a great many of our taxa will be demonstrably ancestor-descendantly related. Such groups conflict with the cladists concept of monophyly since the recognized group does not include all of its descendants i.e. in this case the genus *Lobelia* does not include two of its probable descendants, the segregate genera *Heterotoma* and *Calcaratolobelia*.

Perhaps brief comment is in order concerning the species described by McVaugh (1965) from the northern Andes of Colombia. McVaugh went to some pains to point out that, despite the gibbosity of the hypanthium, his new Columbian species clearly had nothing to do with the Mexican and Central American spurred *lobeliads* formerly placed in the genus *Heterotoma*; morphology suggested to McVaugh that the Andean species apparently was derived from *Lobelia* subg. *Tupa*.

KEY TO THE NORTH AMERICAN SPURRED OR POUCHED GENERA OF THE LOBELIOIDEAE

1. Floral spurs crescent shaped, inflated laterally, the tube narrowing distally and with an abruptly dilated base; corolla red and yellow; calyx lobes attached to the distal end of spur, appressed to corolla tissue **Heterotoma**
1. Floral spurs conical or cylindrical, not inflated laterally, the base not dilated; corolla white, lavender-blue, or pink-purple in spurred species; calyx lobes variously attached to the hypanthium, when distal at the sides of a cylindrical spur, then oriented at a 90° or greater angle from the spur axis... **Calcaratolobelia**

HETEROTOMA Zucc.

Heterotoma Zucc., Flora 15(2) (Beibl.):100. 1832. TYPE SPECIES: *H. lobelioides* Zucc.

Myopsia C. Presl, Prodr. Monogr. Lobel. 8. 1836. TYPE SPECIES: *Myopsia mexicana* C. Presl (= *H. lobelioides* Zucc.).

Perennial, suffrutescent herbs to 1.5 m tall. Leaves petiolate, ovate, pubescent, with acuminate apices, the margin with yellow or purple, gland-tipped teeth. Flowers resupinate by twisting of the ebracteolate pedicel. Hypanthium asymmetrical, the calyx and corolla elongated on the lower side into an arcuate, inflated spur with a bulbous base. Corolla unilabiate, the spur with all 5 lobes on the apparent abaxial side and pointing downward, the tube slit dorsally to base; tube and spur yellow-orange to burgundy; lobes subulate, yellow. Staminal column ca. 2 cm long, exerted vertically from dorsal slit in corolla; ventral filaments adnate to hypanthial rim and continuous with it to base of spur; ventral anthers with many, stiff, subulate trichomes at apex. Corolla, stamens, and style persistent on the fruit. Fruit capsular, dehiscent by apical valves. Seeds numerous (60–100/capsule), ellipsoid, 0.55–0.6 mm long. $n=7$.

1a. *Heterotoma lobelioides* Zucc. var. *lobelioides*, Flora 15(2)(Beibl.):101. 1832. TYPE: MEXICO. OAXACA(?): La Cumbre de San Antonio, 8000 ft, no date, *Karwinski s.n.* (HOLOTYPE: M; ISOTYPES: JE, M, W).

Myopsia mexicana C. Presl, Prodr. Monogr. Lobel. 8. 1836. TYPE: MEXICO. OAXACA(?): La Cumbre de San Antonio, 8000 ft, no date, *Karwinski s.n.* (NEOTYPE: ?).

Lobelia calcarata Bertoloni, Fl. Guatimal. in Novi. Comment. Acad. Sci. Inst. Bononiensis 4:409. 1840. TYPE: GUATEMALA: Pinula, 4200 ft, *J. Donnell Smith* 1925 (NEOTYPE: NY, designated by Ayers 1990).

Heterotoma tonelii Ortgies, in Regel, Gartenflora 12:50. 1863. TYPE: illustration in van Houtte, Fl. Serres 14: pl. 1454. 1863 (LECTOTYPE, designated by Ayers 1990). *H. lobelioides* var. *tonelii* (Ortgies) F. Wimmer, Ann. Naturhist. Mus. Wien. 56:371. 1948.

1b. *Heterotoma lobelioides* Zucc. var. *glabra* Ayers, Syst. Bot. 15:311. 1990. TYPE: MEXICO. SAN LUIS POTOSÍ: in mountains near Santa María del Río, Aug 1876, *Schaffner* 736 (HOLOTYPE: GH; ISOTYPE: US).

CALCARATOLOBELIA

Calcaratolobelia gen. nov. TYPE: *Calcaratolobelia cordifolia* (Hook. & Arn.) Wilbur (= *Lobelia cordifolia* Hook. & Arn.).

Herbae annuae vel perennes. Pedicelli graciles, saepe ebracteolati vel raro infimo cum bracteolis minutis et filiformibus. Hypanthia infirme ad valde asymmetrica, partim in calcari corollae distenta, irregularia. Corolla tubulosa, in uno latere longitudinaliter fissa, basi in calcari plus minusve longum extensa vel solum *gibbosa*; limbus corollae bilabiatus, quinquepartitus. Filamenta a corolla libera, sed duo longiora et in apicem calcaris decurrentia. Antherae 2 minores apice piloso-penicellatae. Stylus filiformis inclusus. Capsula semi-infera.

Annual or perennial herbs (1–)10–70(–150) cm tall. Leaves petiolate or the cauline sometimes sessile. Inflorescences often secund and appearing pedunculate due to the naked upper part of the stem. Pedicels spreading-

ascendent, slender, often ebracteolate or in two species with minute, filiform bracteoles especially on the lowermost pedicels. Flowers inverted in anthesis by the twisting of the pedicel. Hypanthium weakly to strongly asymmetrical, the calyx and corolla extending on the abaxial side into a nectariferous knob or spur, the spur straight, cylindrical or tapering or at least not possessing a bulbous base. Corollas bilabiate with the two upper and three lower lobes, respectively, pointing in opposite directions, the tube slit dorsally to base or at least to within 1 mm of base. Staminal column less than 8 mm long and slightly exerted through the dorsal slit; the 2 shorter anthers with a stubble of numerous, short, apical bristles. $n=7$ or 14 when known.

A small genus of twelve species known only from Mexico and Central America.

Ayers' (1990) key and descriptions adequately summarize the differences between the species and it seems unlikely that they can be improved upon until considerably more material has been collected and evaluated. The revised nomenclature is presented below with the species arranged in the same order as in Ayers' publication except for the insertion of *L. margarita* as species #12.

1. **Calcaratolobelia macrocentron** (Benth.) Wilbur, comb. nov. *Heterotoma macrocentron* Benth., Hooker's Icon. Pl. 12: 68, pl. 1177. 1876. *Lobelia macrocentron* (Benth.) Ayers, Brittonia 39:418. 1987. TYPE: MEXICO. [DURANGO or NAYARIT?]: Sierra Madre, NW of Mexico, Nov–Feb 1849–50, *Seemann* 2049 (HOLOTYPE: K; ISOTYPE: BM).
 2. **Calcaratolobelia villaregalis** (Ayers) Wilbur, comb. nov. *Lobelia villaregalis* Ayers, Brittonia 39:419. 1987. TYPE: MEXICO. JALISCO: cañon humido, Sierra de La Venta, 24 Nov. 1968, *Villareal de Puga* 2463 (HOLOTYPE: MICH; ISOTYPE: IBUG).
 3. **Calcaratolobelia knoblochii** (Ayers) Wilbur, comb. nov. *Lobelia knoblochii* Ayers, Brittonia 39:420. 1987. TYPE: MEXICO. CHIHUAHUA: shaded rocks, Mojarachic, 25 May 1938, *Knobloch* 5097 (HOLOTYPE: F; ISOTYPE: MSC).
 4. **Calcaratolobelia mcvaughii** (Ayers) Wilbur, comb. nov. *Lobelia mcvaughii* Ayers, Brittonia 39:421. 1987. TYPE: MEXICO. DURANGO: 34 road mi W of El Salto, along hwy from Durango to Mazatlán, 24 Mar 1951, *McVaugh* 11528 (HOLOTYPE: MICH; ISOTYPES: MICH, NY, TEX).
 5. **Calcaratolobelia cordifolia** (Hook. & Arn.) Wilbur, comb. nov. *Lobelia cordifolia* Hook. & Arn., Bot. Beechey Voy. 301. 1838. *Heterotoma cordifolia* (Hook. & Arn.) McVaugh, Bull. Torrey Bot. Club 67:143. 1940. TYPE: MEXICO. NAYARIT: vicinity of Tepic, Jan–Feb 1827, *Beechey* s.n. (HOLOTYPE: E; ISOTYPE: K).
- Heterotoma salvadorensis* E. Wimmer, Ann. Naturhist. Mus. Wien 56:371. 1948. TYPE: EL SALVADOR. San Salvador, no date, *Bernouli & Cario* 8 (HOLOTYPE: GOET; ISOTYPES: GOET, W).

6. Calcaratolobelia tenella (Turcz.) Wilbur, comb. nov. *Heterotoma tenella* Turcz., Bjull. Moskovsk. Obsc. Isp. Prir., Otd. Biol. 25(3):175. 1852. *Lobelia volcanica* Ayers, Syst. Bot. 15:317. 1990. TYPE: MEXICO. VERACRUZ: Xalapa, 600 m, Dec 1840, Galeotti 7029 (HOLOTYPE: K; ISOTYPE: BR). *Heterotoma cordifolia* var. *tenella* (Turcz.) F. Wimmer, Pflanzenr. IV. 276b:717. 1953, non *Lobelia tenella* L., Mantissa Pl. 1:120.1771, Thunb. Prodr. Fl. Cap. 40. 1794, non Biv., Sicul. Pl. Cent. 1:53.t.2. 1806.

7. Calcaratolobelia gibbosa (S. Watson) Wilbur, comb. nov. *Heterotoma gibbosa* S. Watson, Proc. Amer. Acad. Arts 23:280. 1888. TYPE: MEXICO. CHIHUAHUA: Oritz, no date, Pringle 1478 (HOLOTYPE: GH), non *Lobelia gibbosa* Labill., Nov. Holl. pl. 1:50. 1805.

Heterotoma endlichii F. Wimmer, Feddes Repert. Spec. Nov. Regni Veg. 26:1 pl.71, f.1. 1929. *Lobelia endlichii* (F. Wimmer) Ayers, Syst. Bot. 15:319. 1990. TYPE: MEXICO. CHIHUAHUA: bei Huejotitan in Tal des Río Balsequillo, 1720 m, 5 Apr 1906, Endlich 1172 (LECTOTYPE: W, designated by Ayers 1990).

8a. Calcaratolobelia flexuosa (C. Presl) Wilbur var. *flexuosa*, comb. nov. *Rapuntium flexuosum* C. Presl, Prodr. Monogr. Lobel. 23.1836. TYPE: MEXICO. presumably collected between Acapulco and Mexico City, no date, Haenke s.n. (HOLOTYPE: PR; photo: NY, US). non *Rapuntium flexuosum* C. Presl, Monogr. Lobel. 16.1836. TYPE: Cape of Good Hope. [*Rapuntium flexuosum* C. Presl (p. 23) has priority over *R. flexuosum* C. Presl (p. 16), see Art. 53. 6. ICBN. 1993.] *Lobelia flexuosa* (C. Presl) A.DC., Prodr. 7:378. 1839. *Heterotoma flexuosa* (C. Presl) McVaugh, Bull. Torrey Bot. Club 67:143. 1940.

Lobelia arabidoides Hook. & Arn., Bot. Beechey Voy. 301. pl. 66. 1838. *Heterotoma arabidoides* (Hook. & Arn.) Benth, Hooker's Icon. Pl. 12:68. 1876. TYPE: MEXICO. NAYARIT: vicinity of Tepic, Jan–Feb 1827, Beechey s.n. (HOLOTYPE: K).

Heterotoma flexuosa var. *liebmanniana* F. Wimmer, Pflanzenr. IV. 276b:718. 1953. TYPE: MEXICO. [Oaxaca?]: “San Miguel de Pueto, Guatala,” no date, Liebmann 7801 (LECTOTYPE, designated by Ayers (1990), who selected from among three syntypes: C).

8b. Calcaratolobelia flexuosa (C. Presl) Wilbur var. *intermedia* (Hemsley) Wilbur, comb. nov. *Heterotoma intermedia* Hemsl., Biol. Centr. Amer. Bot. 2:269.1881. *Heterotoma cordifolia* var. *intermedia* (Hemsley) F. Wimmer, Pflanzenr. IV. 276b:717. 1953. TYPE: MEXICO. [possibly collected between the cities of Durango and Tepic...]: 1850, Seemann 2051 (HOLOTYPE: K; ISOTYPE, BM).

9. Calcaratolobelia goldmanii (Fern.) Wilbur, comb.nov. *Heterotoma goldmanii* Fern., Proc. Amer. Acad. Arts 36:504.1901. *Lobelia goldmanii* (Fern.) Ayers, Syst. Bot. 15: 322. 1990. [as *goldmannii*]. TYPE: MEXICO. SINALOA: road from Las Flechas to La Rostra, 22 Feb 1899, Goldman 324 (HOLOTYPE: GH). [The spelling employed by Fernald, *H. goldmanii*, was altered by Wimmer to *H. goldmannii* (Pflanzenr. IV 276b:715–716. 1953), and this spelling was sometimes adopted by Ayers. The original collector's name was Edward A. Goldman but Wimmer mistakenly cited the collector's name as Goldmann. Article 60 applies; the original spelling must be retained.]

10. Calcaratolobelia aurita (Brandege) Wilbur, comb.nov. *Heterotoma aurita* Brandege, Proc. Calif. Acad. Sci. II. 3:149. 1891. *Lobelia aurita* (Brandege) Ayers,

Syst. Bot. 15:324. 1990. TYPE: MEXICO. BAJA CALIFORNIA DEL SUR: Sierra la Laguna, 21 Jun 1890, *Brandege* 353 (LECTOTYPE: UC, ISOLECTOTYPE: GH).

Lobelia cotensis M.E. Jones, Contr. W. Bot. 15:152. 1929. TYPE: MEXICO. BAJA CALIFORNIA DEL SUR: Cota Ranch, Laguna Mts, 14 mi E of Todos Santos, 21 Feb 1928, *Jones* 24147 (HOLOTYPE: POM, photo at US; ISOTYPES: F, MICH, MO, NY, POM).

Lobelia amabilis M.E. Jones, Contr. W. Bot. 18:68. 1933. TYPE: MEXICO. BAJA CALIFORNIA DEL SUR: The Laguna, Laguna Mts, 22 Sep 1930, *Jones* 27428 (HOLOTYPE: POM; ISOTYPES: BM, MO, NY, US).

11. *Calcaratolobelia pringlei* (B.L. Robinson) Wilbur, comb. nov. *Heterotoma pringlei* B.L. Robinson, Proc. Amer. Acad. Arts 44:615. 1909. TYPE: MEXICO. NUEVO LEÓN: chalky mountains near Doctor Arroyo, 7 Nov 1904, *Pringle* 13274 (HOLOTYPE: GH; ISOTYPES: F, MICH, MO).

Lobelia gypsophila Ayers, Sida 13:144. 1988, based on *Heterotoma pringlei* B.L. Robinson, not *Lobelia pringlei* S. Watson, Proc. Amer. Acad. Arts. 25:157. 1890.

12. *Calcaratolobelia margarita* (F. Wimmer) Wilbur, comb. nov. *Lobelia margarita* F. Wimmer, Ann. Naturhist. Mus. Wien. 56:355. 1948. TYPE: MEXICO. NUEVO LEÓN: Mpio. Galeana, Hacienda Pablillo, 14 Aug 1936, *M. Taylor* 167 (HOLOTYPE: F; ISOTYPE: TEX).

Nothing in this paper should be taken as criticism of Dr. Ayer's admirable contribution which is clearly based on her very careful study with its attention to field work especially in the mountains of Nuevo León. Quite obviously and admittedly my proposed solution is largely one that she listed as an "acceptable" alternative to the one that she prefers.

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SIDEROXYLON ALACHUENSE, A NEW NAME FOR *BUMELIA ANOMALA* (SAPOTACEAE)

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ABSTRACT

Bumelia anomala is transferred to the genus *Sideroxylon*, where the species must be given a new name because the former specific epithet is preoccupied in the latter genus. Additional (new) morphological data are added to the species description, and the species' salient features and rarity are evaluated.

RESUMEN

Bumelia anomala se transfiere al género *Sideroxylon*, donde la especie debe recibir un nombre nuevo porque el epíteto específico está ocupado en este género. Se añaden nuevos datos morfológicos a la descripción de la especie, y se evalúan las características más sobresalientes y raras.

KEY WORDS: Sapotaceae, *Sideroxylon*, *Bumelia*, silver buckthorn, Florida, rare plants, endemics.

The silver buckthorn, *Bumelia anomala* (Sarg.) Clark, has a varied taxonomic history. It was originally described as a variety of *B. lanuginosa* (Michx.) Persoon (Sargent 1921) and was elevated to species rank by Clark (1942). Cronquist regarded it as "an uncommon but widely distributed form" of *B. tenax* (L.) Willd. (Cronquist 1945). Godfrey (1988) treated it as a species, whereas Wunderlin (pers. comm.) includes it within *B. tenax* with no infraspecific taxonomic status. Pennington (1990, 1991) has made a good case for transferring all *Bumelia* into *Sideroxylon*, but he did not mention *B. anomala* at any level.

Our studies indicate that *Bumelia anomala* is a distinctive, rare endemic of central Florida, and that it merits recognition as a species. Unfortunately, the epithet *anomala* is preoccupied within *Sideroxylon*, so a new name is proposed here:

***Sideroxylon alachuense* L.C. Anderson, nom. nov.** BASIONYM: *Bumelia lanuginosa* var. *anomala* Sarg., J. Arnold Arbor. 2:168. 1921. *Bumelia anomala* (Sarg.) Clark, Ann. Missouri Bot. Gard. 29:169. 1942. *Bumelia tenax* forma *anomala* (Sarg.) Cronq., J. Arnold Arbor. 26:456. 1945. TYPE: FLORIDA: [ALACHUA CO.:] Gainesville, 17 Jun 1917, T.G. Harbison 47 (A-2 sheets). Sargent (1921) erroneously listed this collection from Hancock County (which does not exist in Florida), non *Sideroxylon anomalum* (Urban) T.D. Pennington, Fl. Neotropica Monogr. 52:123. 1990.

The species is named for its occurrence at Alachua Sink (type locality), part of Paynes Prairie State Preserve near Gainesville in Alachua County, Florida.

Additional collections: **Alachua Co.:** Paynes Prairie State Preserve near Gainesville, 25 Jul 1918, *T.G. Harbison* 61 (A), *T.G. Harbison* 64 (A); 20 Jul 1919, *T.G. Harbison* 97 (A); 30 Nov 1934, *L.E. Arnold & E. West* s.n. (FLAS); 7 Oct 1980, *W.S. Judd* 2824 (FLAS); 25 Jul 1982, *J.C. Easterday* 932 (FLAS); 7 May 1984, *R.K. Godfrey* 81292 (FSU); 22 Jun 1984, *R.K. Godfrey* 81389 (FSU); 12 Jun 1996 (three trees, Alachua Sink progeny on R.W. Simons' Gainesville property), *L.C. Anderson* 16579 (FSU), *L.C. Anderson* 16580 (FSU), *L.C. Anderson* 16581 (FSU). **Marion Co.:** Silver River State Park, May 1985, *R.W. Simons* s.n. (FSU). **Orange Co.:** near Orlando, 11 Nov 1917, *T.G. Harbison* 51 (A).

Small trees up to 9.2 m tall and 1.3 dm DBH; juveniles occasionally growing as low shrubs, spreading by horizontal rhizomes; long shoots (elongation or leader) bright green and with scattered pale hairs when young, often with sharp green thorns to 20 mm long, at nodes; some thorns becoming short spur-shoots (cf. Godfrey 1988 for illustration). Mature shoots glabrous, gray-white, becoming thick and rigid. Leaves (3–)4–6(–9) cm long, (11–)16–30(–39) mm wide, petioles up to 5 mm long; blades on long shoots ovate-elliptic to rhombic or broadly obovate, tips obtuse to emarginate, those on spur-shoots smaller, usually oblanceolate to elliptic. All blades lustrous, dark green above with finely bony-cartilaginous reticulate veins, metallic-silver below with compacted dolabrate, sericeous hairs that hide the surface. Flowers 5–6-merous, 10–20 in umbellate clusters on spur-shoots, tawny pubescent pedicels 4.5–5 mm long. Calyx 3–4.5(–6) mm long, outer two sepals shorter, nearly orbicular, longer inner sepals narrower and often emarginate; all scruffy pubescent with mostly silver hairs plus small patches of light golden-brown hairs. Corollas white, 4.2–5(–6) mm long, petals 3-pronged, central prong longer and slightly spreading. Staminodes narrowly deltoid, obtuse, rarely minutely erose, nearly as long as and alternate the petals. Stamens opposite the petals, filaments somewhat dilated proximally, 1.7–1.9 mm long, anthers saggitate, 1.4–1.5 mm long. Pistils velutinous, ovaries 1.5–1.8 mm, styles 1.4–1.5 mm long at anthesis. Single-seeded berries shiny black, oblong or rarely ovate, glabrescent with patches of hairs distally, 11–13 mm long and 10–11 mm wide excluding persistent 1–1.5 mm style. Seeds light brown, smooth, 9–10 mm long and 6 mm wide.

This species has often been considered conspecific with *S. tenax*. However, the two entities may be distinguished as follows:

Twigs lightly colored, glabrous or nearly so at maturity. Leaves (3–)4–6(–9) cm long, (11–)16–30(–39) mm wide, dark green above, shiny white below. Flowers 5–6-merous, in small clusters on spur-shoots, on pedicels 4.5–5 mm long, calyces 3–4.5(–6) mm long, anthers 1.4–1.5 mm long, styles 1–1.5 mm long. Flowering mid–late July. *S. alachuense*

Twigs dark brown to golden, coppery, or rusty, densely pubescent. Leaves (2.5–) 4–5(–7.5) cm long, (6–)9–15(–30) mm wide, dull green above and brownish or rusty below. Flowers 4–5-merous, in larger clusters on pedicels 4–9(–12) mm long, calyces 2–2.8 mm long, anthers $\pm$ 1 mm long, styles 1.2 mm long. Flowering early–mid-June in central Florida. *S. tenax*

The silvery dolabrate hairs of *S. alachuense* are strongly appressed and unidirectionally aligned, whereas the generally scruffy brown hairs of *S. tenax* are more interwoven, some twisted and ascending when observed through scanning electron microscopy. Distinctive stomatal patterns on the leaves provide additional characters diagnostic among *Sideroxylon* taxa (Anderson 1996). Stomatal density per unit of leaf surface is lower in *S. alachuense* than in *S. tenax*. The prominent peristomatal rims that nearly hide the guard cells are generally narrower and longer in *S. alachuense* than in *S. tenax*.

Sideroxylon alachuense (as *Bumelia anomala*) is listed as endangered in Florida (Coile 1993). Known occurrences are few; perhaps only 20 plants exist in the wild. About 20 plants are in cultivation in Gainesville through the efforts of R. W. Simons. It is the rarest and perhaps the most beautiful buckthorn in the United States.

ACKNOWLEDGMENTS

Bob Simons is responsible for most of our distributional knowledge about the silver buckthorn. He is thanked for allowing me to collect from his plants, taking me into the field to observe buckthorns, and providing me with flowers and fruits (which are quite tasty). Ted M. Barkley made helpful suggestions on the manuscript.

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BOOK NOTICES

HOLLAND, V.L. and DAVID J. KEIL. 1995. **California Vegetation**. (ISBN 0-7872-0733-0, pbk). Kendall/Hunt Publishing Company, 4050 Westmark Drive, Dubuque, IA 52004-1840. \$42.95. 516 pp.

This book, originally done as a text but now revised for wider use, tells all that an average visitor or resident might want to know about California vegetation. The first 120 pages cover topography, geology, and soils; climate; vegetational history; community classification; and plant names. Most of the rest of the book is devoted to lucid discussions of California's various types of vegetation from marine habitats to alpine areas, including general descriptions, basic environmental factors (e.g., climate, soils, and human impact), and lists of important plants. Concluding each type's section is a list—often extensive—of references for further reading, a most welcome addition. The index is detailed. Liberal use is made of black-and-white photographs, many of them helpful, a few disappointing. Useful, too, are the maps showing locations of the various vegetation types and the ranges of selected California plant species. When you, as a visitor, go to California—or, as a resident, explore your state—take this book with you. You'll be glad you did.—*John W. Thieret*.

SEYMOUR, RANDY. 1997. **Wildflowers of Mammoth Cave National Park**. 1997. (ISBN 0-8131-0898-5, pbk). The University Press of Kentucky, 663 South Limestone Street, Lexington, KY 40508-4008. \$17.95 + \$3.50 shipping. 254 pp.

This book includes color photographs (mostly excellent), earmarks, habitat data, flowering times, and uses/folklore of 400 species found in Mammoth Cave National Park's 53,000 diverse acres. The flowers are arranged, first, by flowering dates and, second, by color. The book tells the user where in the park—i.e., in what areas or along what trails—to find the various flowers, a welcome bonus. This work, a labor of love for its author, is beautifully done. Even if you do not visit the park, *Wildflowers* is a pleasure to look at. If you do visit, you will find the guide useful. I recommend it.—*John W. Thieret*.

KORMONDY, EDWARD J. 1996. **Concepts of Ecology**. Fourth Edition. (ISBN 0-13-478116-3, pbk). Prentice-Hall, Inc., Simon & Schuster/A Viacom Company, Upper Saddle River, NJ 07458, U.S.A. Price not given, 559 pp.

From the cover: "In this new edition, Edward J. Kormondy continues to focus on ecosystem ecology with primary emphasis on energy flow, biogeochemical cycling, population ecology, and community ecology. A final section on human ecology integrates these four major areas. Designed for sophomore and junior students with minimal background in biology and chemistry, terminology is minimized, and elementary mathematics is used for quantitative aspects."

CRATAEGUS NANANIXONII (ROSACEAE,
SER. *INTRICATAE*) A NEW SPECIES OF
HAWTHORN FROM EASTERN TEXAS

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ABSTRACT

A new species of *Crataegus*, *C. nananixonii*, is described from Texas and illustrated. The new taxon is a small plant endemic to sand hills near Nacogdoches.

RESUMEN

Se describe y se ilustra una nueva especie de *Crataegus*, *C. nananixonii*, procedente de Texas. El nuevo taxon es una pequeña planta endémica de las colinas arenosas cerca de Nacogdoches.

In preparation for the forthcoming Flora of Texas, this paper describes a new species of *Crataegus* which has been known for a number of years from sand plains near Nacogdoches, Texas. This species cannot be matched with anything in lists of Texas plants (e.g. Hatch et al. 1990, Johnston 1990, Mahler 1988, Nixon 1985, Simpson 1988, Vines 1977) or Louisiana (MacRoberts 1988). In Correll and Johnston's (1970) *Manual of the Vascular Plants of Texas* it would key down unambiguously to *C. uniflora* Muenchh., if the ripe fruit color were known. However, it is very different from that species, as discussed below.

***Crataegus nananixonii* J.B. Phipps & R.J. O'Kennon, sp. nov. (Fig. 1).**

TYPE: TEXAS: NACOGDOCHES CO.: 1 mi N of jct. of FM1087 and Co. Rd. 153, on Co. Rd. 153, 14 Apr 1989, *E.S. Nixon 17430* (HOLOTYPE: ASTC; ISOTYPE: UWO).

Frutex, 1–2 m altus, intricate ramosus; spinae 1–3 cm longae, tenues, rectae vel plus minusve recurvatae, sordide atrocinereae. Folia decidua, petiolata; laminae 1.5–3.5 cm longae, rhombo-ovatae, vadosissime lobatae vel non-lobatae, marginibus nonnihil irregulariter seratis, in juventute sparsim scabro-pubescentes adaxiale, glabrae abaxiale, in maturitate fere omnino glabrae excepte pubescentia adaxiale in venas, glanduloso-maculatae in allis dentes, praecipue proxime, paribus ca. 3 venarum secundariarum, petioli 5–15 mm

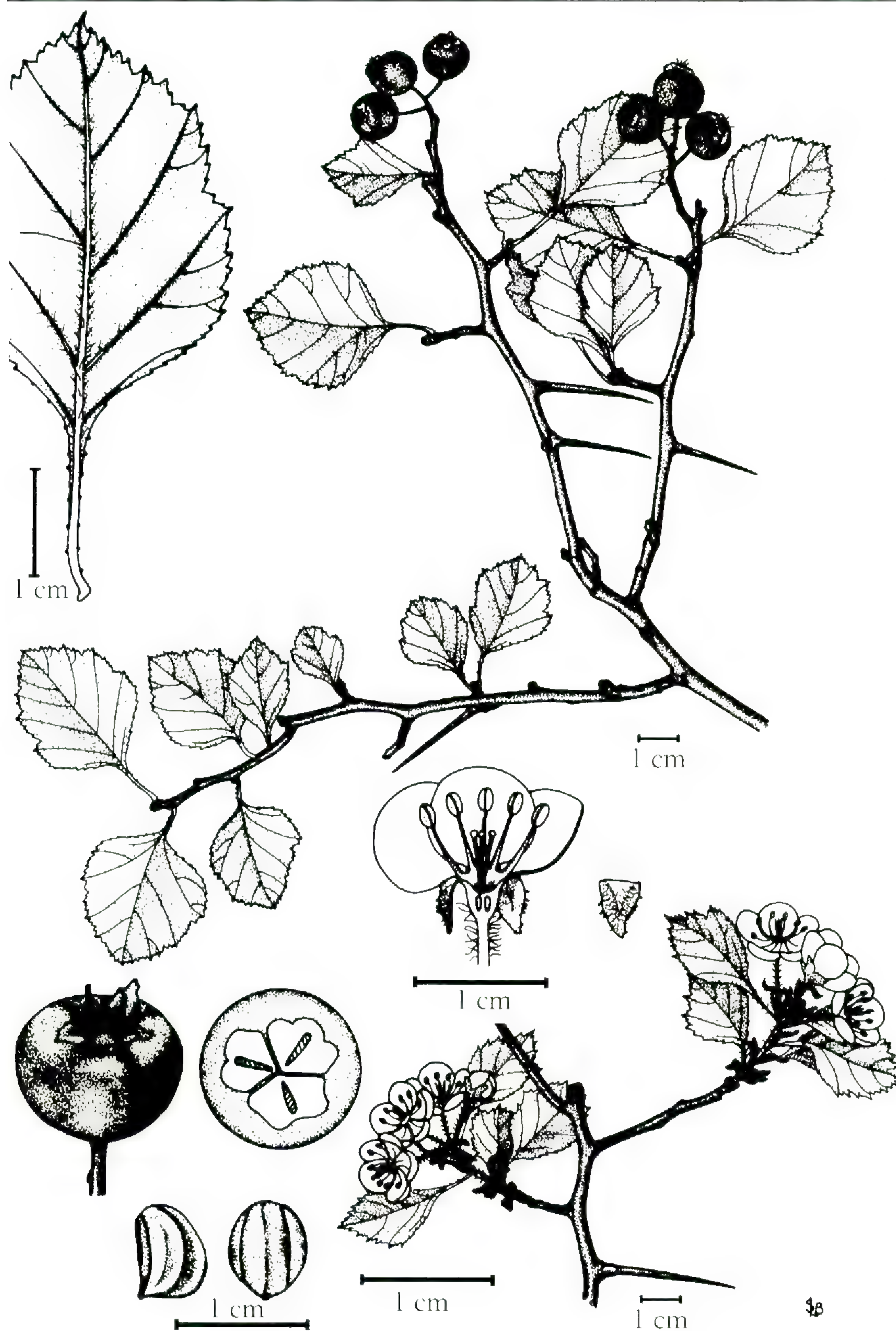


FIG. 1. *Crataegus nananixonii* J.B. Phipps & R.J. O'Kennon. Fruiting specimen, fruit and parts of whole leaf from J.B. Phipps 6277 (UWO). Flowering specimen and flower parts from E.S. Nixon 17340 (UWO). S. Laurie-Bourque del.

longi, glanduloso-maculati. Inflorescentiae 3–5 florum; pedicellis patento-pubescentibus, bracteolis caducis linearis glandulo-marginibus conspicuis in anthesem praecocem; anthesis in Aprili. Flores 12–15 mm diam.; hypanthium glabrum; lobi calycis 4–5 mm longi, glandulo-marginati, glabri adaxiales; petala $\pm$ orbiculares, plus minusve unguiculata; stamina ca. 10, antheris rose-purpureis; carpelli et styla 5. Infructescentiae 1–4 fructae, pedicellis tenuiter patento-pubescentibus. Fructus ca. 1 cm diam., orbiculares, cupreo-rubri, in maturitate glabri, reliquiis calycis adscendentibus vel non in ore leviter elevato; pyrena 5.

Shrub, 1–2.5 m tall, quite intricately branched; thorns 1–3 cm long, fine, straight to slightly recurved, dark dull grey. Leaves deciduous, petiolate; leaf-blades 1.5–3.5 cm long, rhomb-ovate, extremely shallowly lobed or unlobed, margins somewhat irregularly serrate, thinly scabrous-hairy adaxially when young, glabrous abaxially, at maturity almost entirely glabrous except for some pubescence on the veins abaxially, and with gland-dots in some of the teeth especially proximally, with about 3 pairs of secondary veins; petioles 5–15 mm long, gland-dotted. Inflorescence 3–5 flowered, branches with spreading pubescence, caducous linear gland-margined bracteoles conspicuous in early anthesis; anthesis April. Flowers 12–15 mm diam.; hypanthium glabrous; calyx lobes 4–5 mm long, gland-margined, glabrous abaxially; petals $\pm$ orbicular with slight claw; stamens about 10, anthers rose-purple in color; carpels and styles 3–5. Infructescences 1–4 fruited; pedicels with thin spreading pubescence. Fruits 1 cm diameter, $\pm$ orbicular, coppery red when ripe, glabrous, calyx remnants present or not on a slightly elevated rim; pyrenes 3–5.

Additional specimens examined: TEXAS: **Nacogdoches Co.**: ca 1 mi N of jct. of FM 1087 & Co. Rd. 153 on 153, occasional, regenerating on a clearcut area, 1.9 m tall, white flowers, anthers rose-purple, 14 Apr 1989, *E.S. Nixon 17334* (UWO); ca. 1 mi N of jct. of FM 1087 & Co. Rd. 153 on 153, regenerating on a clearcut area, occasional, 1.8 m tall, white flowers, anthers rose-purple, 14 Apr 1989, *E.S. Nixon 17336* (UWO); ca. 1 mi N of jct. of FM 1087 & Co. Rd. 153 on 153, regenerating on a clearcut area, occasional, 1.4 m tall, white flowers, anthers rose-purple, 14 Apr 1989, *E.S. Nixon 17339* (UWO); ca. 1 mi N of jct. of FM 1087 & Co. Rd. 153 on 153, regenerating on a clearcut area, occasional, 2 m tall, white flowers, anthers rose-purple, 14 Apr 1989, *E.S. Nixon 17340* (UWO); ca. 1 mi N of jct. of FM 1087 & Co. Rd. 153 on 153, regenerating on a clearcut area, occasional, 1 m tall, white flowers, anthers rose-purple, 14 Apr 1989, *E.S. Nixon 17342* (UWO); ca. 1 mi N of jct. of FM 1087 & Co. Rd. 153 on 153, regenerating on a clearcut area, occasional, 1.5 m tall, white flowers, anthers rose-purple, 14 Apr 1989, *E.S. Nixon 17343* (UWO); ca. 1 mi N of jct. of FM 1087 & Co. Rd. 153 on 153, regenerating on a clearcut area, occasional, 1.2 m tall, white flowers, anthers rose-purple, 14 Apr 1989, *E.S. Nixon 17344* (UWO); 1.3 mi W of jct. of FM 1087 & Co. Rd. 153 on 1087, dry upland, post oak, shortleaf pine & sandjack oak, 1.8 m tall, white flowers anthers rose-purple, 19 Apr 1989, *E.S. Nixon 17321* (UWO); 1.3 mi W of jct. of FM 1087 & Co. Rd. 153 on 1087, dry upland, post oak, shortleaf pine & sandjack oak, 2.1 m tall, white flowers, anthers rose-purple, 19 Apr 1989, *E.S. Nixon 17322* (UWO); 1.3 mi W of jct. of FM 1087 & Co. Rd. 153 on 1087, dry upland, post oak, shortleaf pine & sandjack oak, 2.1 m tall, white flowers, anthers rose-purple, 19 Apr 1989, *E.S. Nixon 17323* (UWO); 1.3 mi W of jct. of FM 1087 & Co. Rd. 153 on 1087, dry upland, post oak, shortleaf pine & sandjack oak, 2.4 m

tall, white flowers, anthers rose-purple, 19 Apr 1989, *E.S. Nixon 17324* (UWO); 1.3 mi W of jct. of FM 1087 & Co. Rd. 153 on 1087, dry upland, post oak, shortleaf pine & sandjack oak, 2.1 m tall, white flowers, anthers rose-purple, 19 Apr 1989, *E.S. Nixon 17325* (UWO); 1.3 mi W of jct. of FM 1087 & Co. Rd. 153 on 1087, dry upland, post oak, shortleaf pine & sandjack oak, 2.1 m tall, white flowers, anthers rose-purple, 19 Apr 1989, *E.S. Nixon 17326* (UWO); 1.3 mi W of jct. of FM 1087 & Co. Rd. 153 on 1087, dry upland, post oak, shortleaf pine & sandjack oak, 2.4 m tall, white flowers, anthers rose-purple, 19 Apr 1989, *E.S. Nixon 17327* (UWO); 1.3 mi W of jct. of FM 1087 & Co. Rd. 153 on 1087, dry upland, post oak, shortleaf pine & sandjack oak, 2.3 m tall, white flowers, anthers rose-purple, 19 Apr 1989, *E.S. Nixon 17328* (UWO); right-hand side (northwards) of Co. Rd. 153, several miles W of Garrison on FM 1087, just N of scout camp, 31°52'N 94°37'W, 500' a.s.l., extreme sandy soil, sparse scrub of dwarf oak, 1 m bush with clusters of ruddy fruit, 18 Oct 1988, *J.B. Phipps 6277* (UWO); Hwy 1087, 3.7 mi E of Hwy 250, N of Nacogdoches, sandy forest, 13 Apr 1993, *R.J. O'Kennon 11239* (BRIT, UWO).

This distinctive and attractive species is restricted to open sandy scrubland of oak, in Nacogdoches Co., Texas, where it is locally common and we are naming it for Elray S. Nixon, formerly of Stephen F. Austin State University, Nacogdoches, who provided J.B. Phipps with a quantity of flowering material and directed him to its site in September 1988. The first part of the root "nana" recognizes the dwarf stature of the plant.

At first sight, *Crataegus nananixonii* resembles *C. uniflora* Muenchh. of series *Parvifoliae* (Loud.) Rehder, but this is primarily due to its small habit, leaves, flowers, and fruits and few-flowered inflorescences. Detailed characteristics however, are more similar to those of series *Intricatae* (Loud.) Rehder with which *C. nananixonii* shares a thorny nature, rhomb-elliptic leaf shape, glandular leaf-bases and petioles, abundant caducous glandular bracteoles and ruddy fruit with a small collar. Also, the unspecialised calyx lobe of *C. nananixonii* excludes this plant from series *Parvifoliae*. There is, however, a form of *Crataegus uniflora* superficially similar to *C. nananixonii* with rhombic-obtrullate rather than elliptic-obtuse leaves more typical of the species that is widely scattered across the southern states. This has been recorded for Texas on sandhills near Tyler in Smith Co. and also has several flowers to the inflorescence, like *C. nananixonii*, a feature however, not rare in true *C. uniflora*.

The possibility that *Crataegus nananixonii* was in reality a highly dwarfed form of a generally larger species of series *Intricatae* therefore needed to be addressed in some detail and for this purpose we considered those species listed in Vines (1960), i.e. all members of the series occurring west of the Mississippi. *Crataegus intricata*, *C. neobushii*, *C. buckleyi*, *C. rubella*, *C. padifolia* and *C. pagensis* may be rejected immediately on account of their glabrous inflorescences and young foliage since this is a generally reliable character at the species level in North American *Crataegus* taxonomy. Among the species with pubescent inflorescence and foliage all are much too large but

need to be compared, nevertheless. Of those with some substantive similarity to *C. nananixonii*, *C. harveyana* and *C. ouachitensis* have deep-pink, rose purple or rose-colored ('red' in Vines' key) anthers but 20 stamens while *C. biltmoreana* has 10 stamens but cream-colored anthers. Stamen number and anther color are, of course, two generally good taxonomic characters at the species level in *Crataegus* and have been considered so by Sargent, Palmer, Kruschke and J.B.Phipps, among others. Indeed, Kruschke (1965) took an absolutist stance on the stamen number issue declaring the impossibility of 10 and 20-stamen entities belonging to the same species. In examining section *Douglasii* (black-fruited hawthorns) Dickinson et al. (1996) have shown that 20-stamen forms are self-incompatible, often diploid (and presumably always sexual) while 10-stamen forms are self-compatible, often not diploid (and may be apomictic), thus providing an explanation for Kruschke's viewpoint. My own (JBP) opinion, however, is that the distinction is not necessarily that rigid and that this could be in part due to the stage of evolutionary divergence reached at a particular point in time. The point to note, however, is that stamen number and anther colour are strong characters and that in the case of *C. nananixonii* they support its specific status as a rare local edaphic Texan (for the time being) endemic rather than as a dwarfed form of some other species in series *Intricatae*.

ACKNOWLEDGMENTS

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PALYNOLOGICAL EVIDENCE SUPPORTING THE IDENTITY OF TWO TAXA OF *BERBERIS* (BERBERIDACEAE) FROM TIBET

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ABSTRACT

The identity of *Berberis replicata* var. *dispar* and *B. griffithiana* var. *pallida* is supported on the basis of pollen morphology. Phylogenetically *B. replicata* was found to be a primitive, and *B. griffithiana* an advanced taxa.

RESUMEN

La identidad de *Berberis replicata* var. *dispar* y *B. griffithiana* var. *pallida* se mantiene en base a la morfología polínica. Filogenéticamente *B. replicata* es un taxon primitivo, y *B. griffithiana* uno derivado.

INTRODUCTION

In continuity of Husain et al. (1994) paper on *The identity of two taxa of Berberis (Berberidaceae) from Tibet*, the identity of *Berberis replicata* W.W. Sm. var. *dispar* Ahrendt and *B. griffithiana* Schneid. var. *pallida* (Hk.f. & Th.) Chamberlain & Hu—is discussed in the light of pollen morphological characters using light and scanning electron microscope.

MATERIAL AND METHODS

Polliniferous material for the present study was obtained in the form of dried flower buds from Herbarium sheets. The material was soaked in 70% alcohol for 48 hours and pollen was subsequently acetolysed according to the method of Erdtman (1952). One part of the acetolysed pollen was mounted on slides in glycerine jelly and observed under compound microscope while the other part was mounted on brass stub, gold coated, observed and photographed under scanning electron microscope.

RESULTS AND DISCUSSION

The morphological characters of the three taxa (distributed in Eastern Himalaya and China) namely *B. replicata* var. *dispar* (India: Arunachal

Pradesh: *T. S. Rana & Party* 210335, LWG), *B. griffithiana* var. *griffithiana* (India: Arunachal Pradesh: *T. S. Rana & Party* 210330, LWG) and *B. griffithiana* var. *pallida* (China: *Ludlow, Sheriff & Taylor* 3697, BM) are tabulated and a key for the segregation of *B. replicata* and *B. griffithiana* are provided in Husain et al. (*l. c.*) communication. The pollen morphology of these taxa is given in Table 1 and explained as follows:

Berberis replicata* var. *dispar (Figs. 1, 2)

Grains inaperturate, 2–3 colpoid streaks occur in association with irregular fissures on the exine surface. Exine 1.7 μm thick; ectoexine equal to endoexine, columella indistinct; surface psilate, ill-defined with irregular folds. Grains spheroidal; diam 45 μm (44–47 μm); tectum ill-defined.

Berberis griffithiana (Figs. 3–6)

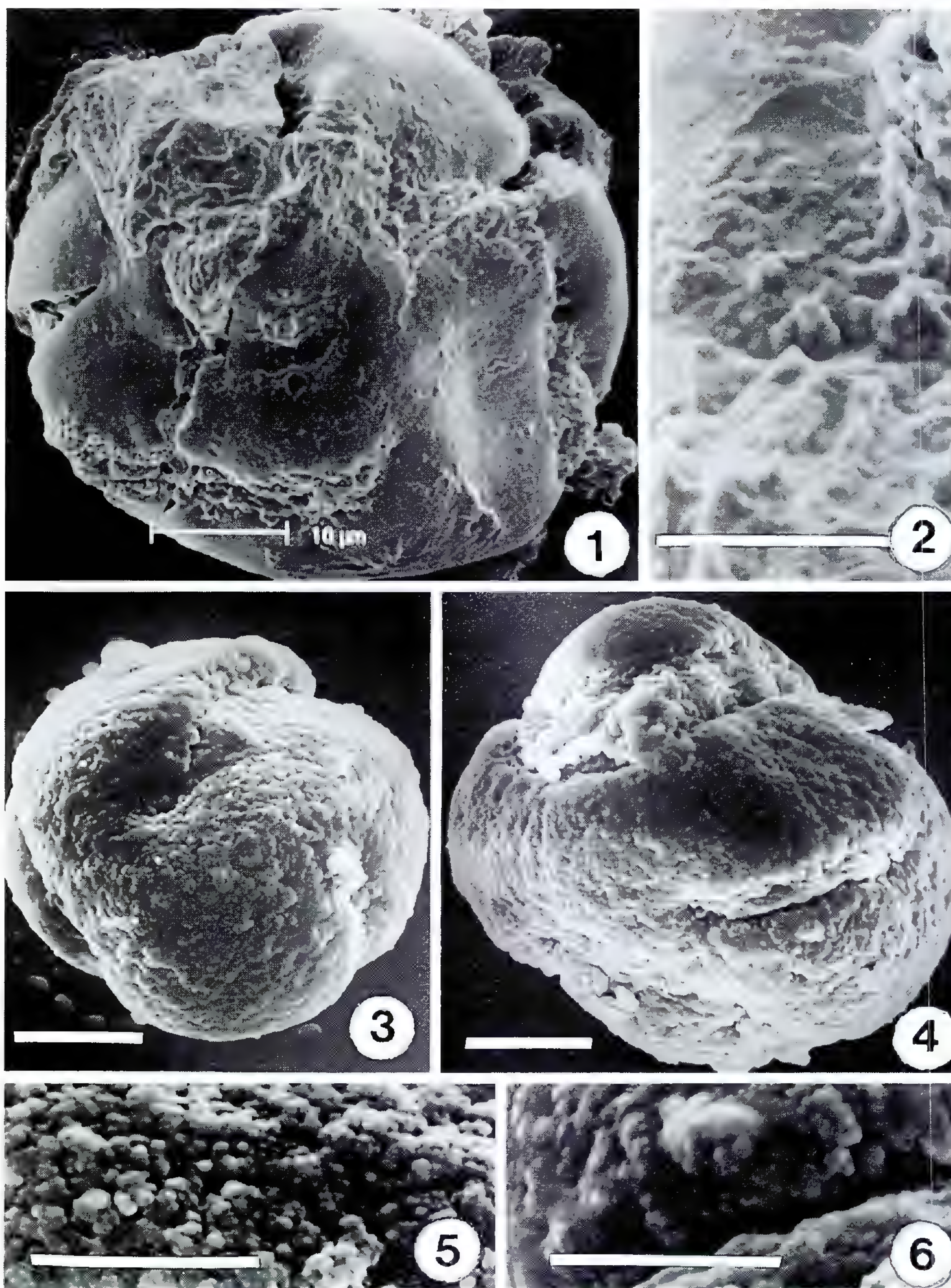
Grains spiraperturate, spiral twines irregularly dileneating the surface into elongated and rounded areas; aperture narrow, margin smooth. Exine 3 μm thick, ectoexine thicker than the endoexine, columella indistinct; surface coarse, organised into irregular raised lumps of piloid elements or warted. Grains spheroidal, diam 34/40 μm (32–42 μm). Tectum irregular.

KEY TO VARIETIES

1. Grains spheroidal; diam 34 μm ; surface with closely packed, homogenous piloid elements var. *griffithiana*
1. Grains sub-spheroidal; 37 $\times$ 40 μm ; surface warted var. *pallida*

The pollen grains of *B. griffithiana* var. *griffithiana* and *B. griffithiana* var. *pallida* were found to be similar to each other but revealed considerable differences with those of *B. replicata* var. *dispar* in primary (apertural), secondary (exine ornamentation) and tertiary (exine strata, shape and size) characters (see Table 1). This supports the view of Husain et al. (*l. c.*) that *B. replicata* var. *dispar* is a distinct taxonomic entity and being closer to *B. replicata* in macro-morphological characters, should be kept as a variety under *B. replicata* and not be merged under *B. griffithiana* var. *pallida*.

Walker and Doyle (1975) phylogenetically classified pollen with respect to the number of apertures as (i) Inaperturate (ii) mono-aperturate (iii) di-aperturate (iv) tri-aperturate or (v) poly-aperturate with 4,5,6 apertures and aperture shape as (i) elongate, furrow like (ii) round, pore like (iii) encircling ring or band like. The pollen grains of *B. replicata* var. *dispar* are basically inaperturate, the primitive type whereas those of *B. griffithiana* are spiraperturate (encircling the grain), the advanced type. Hence, *B. replicata* is considered primitive and *B. griffithiana* advanced. The two taxa represent the two extreme ends of the evolutionary status and thus strongly support the distinct identity of these two taxa.



FIGS. 1–6 Scanning electron micrographs of pollen.

FIGS. 1–2. *Berberis replicata* var. *dispar*, 1) surface with cracks and fissures. 2) surface enlarged showing irregular folds.

FIGS. 3–6. *Berberis griffithiana*, 3) pollen with semi-spiral. 5) surface with piloid elements. 4,6) var. *pallida*, 4) pollen with one free colpus. 6) warted surface.

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NOMENCLATURAL NOTES AND A SYNOPSIS OF THE GENUS *MYRSINE* (MYRSINACEAE) IN MESOAMERICA

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ABSTRACT

A nomenclatural summary is provided for the species of the genus *Myrsine* occurring in Mesoamerica. An updated description of the genus and its taxonomic synonyms is provided, along with a key to the species. Seven taxa are recognized, including the new combination *Myrsine coriacea* (Sw.) R. Br. ex Roem. et Schult. subsp. *nigrescens* (Lundell) Ricketson & Pipoly. All taxa are enumerated, nomenclatural and taxonomic synonyms provided, and two species, *Myrsine juerguensenii* and *M. pellucidopunctata*, are lectotypified. Sixteen binomials are newly relegated to synonymy.

RESUMEN

Se ofrece un resumen de las especies mesoamericanas pertenecientes al género *Myrsine*. Se incluye una descripción actualizada del género y sus sinónimos taxonómicos, junto con una clave para identificar las especies. Se reconocen siete taxa, incluyendo la nueva combinación *Myrsine coriacea* (Sw.) R. Br. ex Roem. et Schult. subsp. *nigrescens* (Lundell) Ricketson & Pipoly. Se enumeran los taxa, se ofrecen sinónimos tanto nomenclaturales como taxonómicos, y se lectotipifican dos especies, *Myrsine juerguensenii* and *M. pellucidopunctata*. Se relegan dieciséis binómenes como nuevos sinónimos taxonómicos.

INTRODUCTION

The genus *Myrsine* R. Br. contains ca. 300 species of which nearly 1/4 remain undescribed. C. Chen and Pipoly (1996), Pipoly (1991, 1992a, 1992b, 1996) and Pipoly and C. Chen (1995) have provided summaries of evidence for broader circumscription of the genus, particularly to include *Rapanea* Aubl. The genus is pantropically distributed, occurring in diverse vegetation types, from mangroves to subalpine scrub, but always in moist, wet or pluvial habitats. The genus is defined by lateral (axillary), fascicu-

late or umbellate inflorescences, sessile or on short, perennating peduncles girdled by persistent floral bracts, thus forming "short shoots." In preparation for our treatment of the genus for *Flora Mesoamericana*, it became necessary to assemble complete synonymies and bibliographic references, and lectotypify several species. Because of the somewhat abbreviated format of that Flora, the present synopsis is intended to provide a complete nomenclator for this often misunderstood and nomenclaturally complex genus.

TAXONOMIC TREATMENT

Myrsine L., Sp. Pl. 1:196. 1753, Gen. Pl. ed 5:90. 1754; Roem. & Schult., Syst. Veg. 503. 1819; A. DC., Trans. Linn. Soc., London, Bot. 17:104. 1834, Ann. Sci. Nat. Bot. 9:292. 1834, Ann. Sci. Nat. Bot. 16:65–97, 129–196, tab. 1–3, 8–9, 1841; A. DC in DC, Prodr. 8:92. 1844. Miq. in Mart., Fl. Bras. 10:306. 1856. Hook. f. in Benth. & Hook., Gen. Pl. 2:642. 1876. Mez in Engl., Pflanzenr. 9(IV. 236):338. 1902. E. Walker, Philipp. J. Sci. 73:1940, Bot. Mag. Tokyo 67:249. 1954, Bull. Ag. Home Ec. Univ. Ryuku 2:76. 1955, Quart. J. Taiwan Mus. 12:164. 1959. Stearn, Bull. Brit. Mus. (Nat. Hist.), Bot. 4:174. 1969. Fosberg & Sachet, Smithsonian Contr. Bot. 21:3–11. 1975. Lundell, Phytologia 48:137. 1981, Phytologia 56:418. 1984. Pipoly, Novon 1:204. 1991, Caldasia 17:1. 1992, Novon 2:392. 1992; Pipoly & C. Chen, Novon 5:360. 1995; Y. B. Harvey & Pipoly, Fl. Pico das Almas 487. 1995; C. Chen & Pipoly, Fl. China 15:34–38. 1996; Pipoly, Sida 17:115–162. 1996. TYPE SPECIES (by monotypy): *Myrsine africana* L.

Rapanea Aubl., Hist. Pl. Guiane 1:121. t. 46. 1775.

Duhamelia Dombey ex Lam., Encycl. 1:245. 1783.

Samara Sw., Prodr. 1:120. 1788. *pro parte, non* L.

Manglilla A. Juss., Gen. Pl. 151. 1789.

Arthrophyllum Lour., Fl. Cochinch. 1:120. 1790.

Caballeria Ruiz & Pav., Fl. Peruv. Prodr. 1:141. 1794.

Roemeria Thunb. (*non alior*) Nov. Gen. Pl. 9:130. 1798.

Scleroxylum Willd., Ges. Naturf. Freunde Berlin Mag. Neuesten Entdeck. Gesammten Naturk. 3:57. 1809.

Suttonia A. Rich., Ess. Fl. Nouv.-Zel. 349. pl. 38. 1832.

Merista Banks & Sol. ex A. Cunn. in A. DC. in DC., Prodr. 8:95. 1844.

Shrubs or small trees. *Leaves* alternate. *Inflorescences* lateral (axillary), umbellate or fasciculate, sessile or on short accrescent branchlets girdled by persistent floral bracts. *Flowers* 4–5(–6)-merous, bisexual or unisexual, the plants then bisexual, monoecious, dioecious, or polygamous; sepals nearly free or united to 1/2 their length, imbricate or valvate, usually ciliate, punctate, persistent; petals nearly free or rarely united to 1/2 their length, usually ciliate, glandular-granulose at least along margin and often throughout within, punctate; stamens and staminodes similar, subequal to corolla length, the filaments free or connate basally to form a tube, the tube with or without sterile appendages alternating with the filaments, and all merely adnate to the corolla tube; or developmentally fused throughout, the

anthers thus appearing epipetalous, the anthers and antherodes similar, ovate or reniform, elliptic or oblong, rarely sagittate, 2-celled, dehiscing by longitudinal slits, or rarely by subterminal pores opening later into wide longitudinal slits; pistil and pistillode similar; conic, obturbinate, obnapiform, or variously subglobose; ovary globose, costate or not, glabrous or glabrescent; ovules few, uniseriate, completely immersed in placenta or seated below apical pores in placenta or variously projecting; style obsolete to present, tapering into stigma; stigma morchelliform, liguliform, sinuate to lobate, prismatic and 3-lobed, or rarely conical. *Fruit* a globose, subglobose, ellipsoid, ovoid, or subovoid drupe, with somewhat fleshy exocarp and crusty or leathery endocarp, 1-seeded; endosperm horny, ruminate; embryo cylindric, transverse.

In Mesoamerica, six species are known, that may be distinguished by the following key.

KEY TO MYRSINE OF MESOAMERICA

1. Branchlets, petioles and/or midrib of leaf blade ferrugineous to rufous tomentose, at times early glabrescent, the trichomes uniseriate.
 2. Leaf blades obovate-spathulate, suborbicular or rarely widely oblong, 0.6–3.5 cm long, the midrib forming a terminal mucron; petioles up to 0.4 cm long 1. *M. dependens*
 2. Leaf blades elliptic, oblong, oblanceolate or lanceolate, 2.5–13 cm long, the midrib not forming a terminal mucron; petioles 0.1–2 cm long.
 3. Branchlets usually persistently ferrugineous to rufous tomentose; midrib of leaf blade usually glabrous above 2a. *M. coriacea* subsp. *coriacea*
 3. Branchlets glabrous, usually ferrugineous only along margins of terminal buds and petioles; midrib of leaf blade ferrugineous tomentose above 2b. *M. coriacea* subsp. *nigrescens*
1. Branchlets, petioles and midrib of leaf blade glabrous or glandular-granulose.
 4. Lower leaf surface prominently punctate and punctate-lineate, bearing large hydropotes, scattered over the abaxial surface, leaf margins flat to inrolled; stigma sessile 3. *M. pellucidopunctata*
 4. Lower leaf surface conspicuously but not prominently punctate or prominently punctate-lineate, bearing small hydropotes densely distributed over the abaxial surface, leaf margin usually inrolled to revolute; stigma sessile or stylopodic.
 5. Flowering shoots 5–13 mm long, 4–5 mm wide; flowers 3–5 mm long; fruits 4–6 mm diameter 4. *M. calcarata*
 5. Flowering shoots 1.5–4 mm long, 1.5–3 mm wide; flowers 2.2–3.2 mm long; fruits 3–4.5 mm diameter.
 6. Branchlets prominently lenticellate; inflorescence umbellate; pedicels 1–3.5 mm long; stigma on a stylopodium; fruits globose to depressed globose; plants of premontane, montane or cloud forests (500–3,000 m), Mexico to Panama 5. *M. juergensenii*
 6. Branches without prominent lenticels; inflorescence fasciculate; pedicels 0.5–1.5 mm long; stigma sessile on the ovary; fruits ellip-

soid; plants of lowland coastal forests and mangroves (0–300 m), along the coast of the Gulf of Mexico and the Caribbean, Mexico to Panama 6. *M. cubana*

1. ***Myrsine dependens*** (Ruíz & Pav.) Spreng., Syst. Veg. 1:664. 1825.

Caballeria dependens Ruiz & Pav., Syst. Veg. Fl. Peruv. Chil. 281. 1798. *Manglilla dependens* (Ruíz & Pav.) Roem. & Schult., Syst. Veg. 4:506. 1819. *Rapanea dependens* (Ruíz & Pav.) Mez in Engl., Pflanzenr. 9(IV. 236):377. 1902. TYPE: PERU. HUÁNUCO: Near Muña, *H. Ruiz & J. Pavón s.n.* (HOLOTYPE: MA; ISOTYPES: F, G-DEL).

Myrsine ciliata Kunth in H.B.K., Nov. Gen. Sp. 3:248. 1819. *Rapanea dependens* (Ruíz & Pav.) Mez in Engl. var. *ciliata* (Kunth) Cuatrec., Rev. Acad. Colomb. Ci. Exact. 8:324. 1951. TYPE: COLOMBIA. Without locality, *A. von Humboldt & A. Bonpland* 326 (HOLOTYPE, P).

Samara myrtifolia Willd. ex Schult. & J.H. Schult. in Roem. & Schult., Mant. 3:220. 1827. *Myrsine myrtifolia* (Schult. & J.H. Schult.) A. DC. Prodr. 8:103. 1844. TYPE: COLOMBIA. Without locality, *A. von Humboldt & A. Bonpland s.n.* (HOLOTYPE: P). According to TL-2, the third volume of *Mantissa* was co-authored by Julius Herman Schultes, son of Josef August Schultes, in their revision of the Syst. Veg. that Josef and Johann Jakob Roemer had written earlier. Therefore, we have changed the literature citation customarily used for the basionym accordingly.

Caballeria myrtifolia Ruiz & Pav. ex A. DC. in DC, Prodr. 8:102. 1844. *pro syn. nom. inval.* TYPE: PERU. Without locality, *H. Ruiz & J. Pavón s.n.* (HOLOTYPE: G-DEL; ISOTYPES: G-BOIS, MA).

Myrsine myrtoides Hook. f., Icon. Pl. t. 87. 1852. *Rapanea myrtoides* (Hook. f.) Mez in Engl., Pflanzenr. 9(IV. 236):377. 1902. *Rapanea ciliata* (Kunth) Cuatrec. var. *myrtoides* (Hook. f.) Cuatrec., Trab. Mus. Nat. Ci. Nat. Ser. Bot. 33:108. 1936. *Rapanea dependens* (Ruíz & Pav.) Mez in Engl. var. *myrtoides* (Hook. f.) Cuatrec., Rev. Acad. Colomb. Ci. Exact. 8:325. 1951. TYPE: COLOMBIA. NARIÑO: Volcán de Pasto, 4,000 m, *W. Jameson* 449 (HOLOTYPE: K).

Rapanea pittieri Mez in Engl., Pflanzenr. 9(IV. 236):378. 1902. *Myrsine pittieri* (Mez) Lundell, Phytologia 48:142. 1981. TYPE: COSTA RICA. CARTAGO: Volcán Irazú, 3,000 m, *H. Pittier* 14111 (HOLOTYPE: B-destr.; LECTOTYPE: by Pipoly 1992b, BR; ISOLECTOTYPE: US).

Rapanea peruviana Lundell, Wrightia 6:117. 1980. SYN. NOV. *Myrsine peruviana* (Lundell) Lundell, Phytologia 48:142. 1981. TYPE: PERU. CUZCO: Tres Cruces, upper edge of Parque Nacional de Manú, 1–13 km NW of Paucartambo-Pilcopata Road, 3,300–3,500 m, 29 Jun 1978, *A. Gentry et al.* 23478 (HOLOTYPE: LL-TEX; ISOTYPES: MO, USM).

Rapanea pittieri Mez var. *chirripoensis* Suessenguth, Bot. Jahrb. Syst. 72:281. 1942. SYN. NOV. TYPE: COSTA RICA. SAN JOSÉ: Chirripó Grande, 28 Apr 1932, *W. Kupper* 1140 (HOLOTYPE: M; ISOTYPE: M.)

Considerable leaf variation occurs in *Myrsine dependens* throughout its range reminiscent of that found among Asian species distributed over broad archipelagos. Populations corresponding to *Myrsine ciliata* are notable only for their longer glandular cilia along the leaf margins while in bud. Populations corresponding to the types of *Samara myrtifolia*, *Caballeria myrtifolia*, and *Myrsine myrtoides* are notable only because the leaf blades are cartilaginous in texture, much smaller, and almost plicate. It is interesting to note that

exactly the same leaf variation is seen in taxa from New Guinea, where *Rapanea cacuminum* Mez is a vegetative match to the type of *Myrsine dependens*, while *Rapanea velutina* corresponds to *Myrsine myrtoides* (both *Rapanea* species will be transferred to *Myrsine*). In other words, quantitative foliar variation was responsible for their segregation in each case. The type of *Rapanea pittieri* was distinguished by Mez solely because of the epunctate (vs. punctate) dorsal side of the anthers. Our study of interpopulational variation revealed that the difference is a matter of conspicuous punctations (Costa Rican populations) vs. prominently raised punctations (Colombian to Peruvian populations). While carrying out fieldwork in Costa Rica and Colombia, I have found that this varies even within populations. Populations corresponding to the type of *Rapanea peruviana* Lundell have a denser and deeper red-colored tomentum than the average, and those of *Rapanea pittieri* var. *chirripoensis* are in all ways exact matches to the type of *Myrsine dependens*. Such a broad ranging, polymorphic species has been termed a "polymorphic ochlospecies" by White (1962), Prance (1982), and Pipoly (1983). Variation in these species is not clinal or necessarily ecotypic; rather it appears to be a series of uncorrelated permutations in quantitative characteristics.

2. *Myrsine coriacea* (Sw.) R. Br. ex Roem. & Schult.

As here circumscribed, *Myrsine coriacea* is the most widespread neotropical species and perhaps the only "weedy" neotropical member of the Myrsinaceae. It is the most polymorphic of the ochlospecies found in any myrsinaceous genus. While vegetative plasticity is greater in this species than in any other in the family, the conic-morchelliform stigma is unique. Among the other distinguishing features of this species are the few-flowered, sessile, fasciculate inflorescences, subsagittate anther and antherode bases, the persistent ferrugineous tomentum of the vegetative organs and pedicels, and the small, globose fruits. The only consistent difference we can find between populations corresponding to the type specimen of *Myrsine coriacea* and those corresponding to that of *M. nigrescens* (Lundell) Lundell, is that in populations of the latter, the persistent tomentum is restricted to the petioles and adaxial leaf midrib, and the populations are largely restricted to open areas of wind-swept elfin forests. Therefore, we consider *M. nigrescens* a subspecies of *M. coriacea*, and make the following new combination.

2a. *Myrsine coriacea* (Sw.) R. Br. ex Roem. & Schult. subsp. *coriacea*, Syst. Veg. 4:511. 1819. *Samara coriacea* Sw., Prodr. 1:32. 1788. *Rapanea coriacea* (Sw.) Mez in Urban, Symb. Antill. 2:428. 1901. TYPE: JAMAICA. Without locality, without date, *O. Swartz s.n.* (HOLOTYPE: BM).

Caballeria ferruginea Ruíz & Pav., Syst. Veg. Fl. Peruv. Chil. 280. 1798. *Manglilla ferruginea* (Ruíz & Pav.) Roem. & Schult., Syst. Veg. 4:506. 1819. *Myrsine ferruginea* (Ruíz & Pav.) Spreng., Syst. Veg. 1:664. 1825. *Rapanea ferruginea* (Ruíz & Pav.) Mez in

- Urban, Symb. Antill. 2:429. 1901. TYPE: PERU. HUÁNUCO: Near. Muña, Without date, *H. Ruiz et J. Pavón s.n.* (HOLOTYPE: MA; ISOTYPE: G).
- Myrsine popyananensis* Kunth in H.B.K., Nov. Gen. Sp. 3:249. 1819. TYPE: COLOMBIA. CAUCA: Near Popayán, 1,000 m, *Humboldt & Bonpland* 1908 (HOLOTYPE: P).
- Myrsine jelskii* Zahlbr., Ann. K. K. Naturhist. Hofmus. 7:3. 1892. *Rapanea jelskii* (Zahlbr.) Mez in Engl., Pflanzenr. 9(IV. 236):379. 1902. TYPE: PERU. CAJAMARCA: Near Cutervo, *C. von Jelski* 15 (HOLOTYPE: W; ISOTYPE, PR).
- Samara saligna* Willd. & J.H. Schult. in Roem. & Schult., Mant. 3:220. 1827. *Myrsine saligna* (Schult. & J.H. Schult.) A. DC., Prodr. 8:103. 1844. TYPE: *Herb. Willd.* 1039 (B-WILLD, n.v.).
- Myrsine myricoides* Schltdl., Linnaea 1833: 525. 1833. SYN. NOV. *Rapanea myricoides* (Schltdl.) Lundell, Wrightia 3:109. 1964. TYPE: MEXICO. JALAPA: *H. Galeotti* 521, 522, 526 (SYNTYPES BR, F, G, HAL). We defer lectotypification of this binomial until all materials cited in the protologue and their duplicates can be assembled.
- Myrsine tomentosa* Presl, Reliq. Haenk. 2:63. 1835. TYPE: PERU. HUÁNUCO: Without further locality, *T. Haenke s.n.* (HOLOTYPE: PR).
- Myrsine viridis* Rusby, Mem. Torrey Bot. Club 6:74. 1896. TYPE: BOLIVIA. LA PAZ: Mapiri, Jul–Aug 1892, *M. Bang* 1476 (HOLOTYPE: NY).
- Myrsine guatemalensis* Gand., Bull. Soc. Bot. France 65:57. 1918. TYPE: GUATEMALA. ALTA VERAPAZ: Coban, 1,350 m, Dec 1906, *H. von Türckheim* 1001 (HOLOTYPE: P; ISOTYPES: F, G, LL-TEX, MICH, MO).
- Rapanea rufa* Lundell, Wrightia 5:298. 1976. SYN. NOV. *Myrsine rufa* (Lundell) Lundell, Phytologia 48:142. 1981. TYPE: COSTA RICA. SAN JOSÉ: Cordillera de Talamanca, Pacific Slope of the Chirripó Massif, 2,700–3,000 m, 6 Apr 1969, *G. Davidse & R. Pohl* 1635 (HOLOTYPE: LL-TEX; ISOTYPE: MO).
- Myrsine vestita* Lundell, Wrightia 7:274. 1984. SYN. NOV. *Rapanea vestita* (Lundell) Lundell, Phytologia 58:490. 1985. TYPE: COSTA RICA. PUNTARENAS: Cordillera de Talamanca, slopes between Cerro Echandí and Cerro Burú, 2,600–2,700 m, 24 Aug 1983, *G. Davidse et al.* 24018 (HOLOTYPE: LL-TEX; ISOTYPES: CR, MO).
- Myrsine microcalyx* Lundell, Phytologia 58:277. 1985. SYN. NOV. *Rapanea microcalyx* (Lundell) Lundell, Phytologia 58:490. 1985. TYPE: PANAMA. CHIRIQUÍ: Cerro Colorado, 24 mi on gravel road from bridge over Río San Félix, 1,430 m, 22 Nov 1979, *T. Antonio* 2619 (HOLOTYPE: LL-TEX; ISOTYPE: MO).

As noted above, this highly variable species exhibits great variation in quantitative features of its vegetative parts, and also in such features as the degree of curvature of the leaf base (obtuse, rounded or acute), leaf shape, vestiture thickness and trichome length, number of flowers and internode length. All of these factors are responsible for the various segregates that have been recognized in the past, including the new ones synonymized above. We believe we have assembled material from throughout subsp. *coriacea*'s range for the first time since Mez's work in 1902 and only for that reason have we been able to appreciate how broadly variation occurs within and among populations, that has convinced us to adopt a very broad species concept. One of the new synonyms, *Myrsine microcalyx*, is a bisexual growth form with consequent quantitative floral variation.

2b. *Myrsine coriacea* (Sw.) R. Br. ex Roem. & Schult. subsp. *nigrescens*

(Lundell) Ricketson & Pipoly, comb. et stat. nov. *Myrsine nigrescens* Lundell, Phytologia 56:418. 1984. *Rapanea nigrescens* (Lundell) Lundell, Phytologia 58:490. 1985. TYPE: PANAMÁ. BOCAS DEL TORO: Cordillera de Talamanca, headwaters of the Río Columbre, 6 airline km NW of the peak of Cerro Echandí on the Costa Rica-Panamanian international border, 2,450–2,600 m., 2–3 March 1984, *G. Davidse et al.* 25239 (HOLOTYPE: LL-TEX; ISOTYPE: LL-TEX, MO).

We have chosen to relegate *Myrsine nigrescens* to synonymy under *Myrsine coriacea* because we have not found any unique features by which we may define it. However, a combination of characters, including the tomentum restricted to the margins of leaf buds and petioles, and tomentose midrib of the leaf, are correlated with its habitats in open areas of wind-swept elfin forests, can be used to distinguish a series of populations consistently. Therefore, we recognize those populations as at the subspecific level. Our subspecies concept follows Pipoly (1987).

3. *Myrsine pellucidopunctata* Oerst., Vidensk. Meddel. Dansk Naturhist. Fören Kjøbenhavn. 133. 1861. *Rapanea pellucido-punctata* (Oerst.) Mez in Engl., Pflanzenr. 9(IV. 236):393. 1902. TYPE: COSTA RICA. CARTAGO: "In monte Irasuense, Orsted legit, Jan 1847, A.S. Oersted. 30" (LECTOTYPE, here designated: C).

Rapnaea panamensis Lundell, Wrightia 4:169. 1971. SYN. NOV. *Myrsine panamensis* (Lundell) Lundell, Phytologia 48:142. 1981. TYPE: PANAMA. Panamá: San José Island, Perlas Archipelago, Gulf of Panama, ca. 55 mi SSE of Balboa, main road W of Matta Puerco, 9 Nov 1944, *I.M. Johnston* 441 (HOLOTYPE: LL-TEX; ISOTYPES: GH, MO, US).

Myrsine sytsmae Lundell, Phytologia 58:278. 1985. SYN. NOV. *Rapanea sytsmae* (Lundell) Lundell, Phytologia 58:490. 1985. TYPE: PANAMA. Los Santos: Road to El Cortezo, 100–200 m, 24 Jan 1981, *W D'Arcy & K. Sytsma* 14355 (HOLOTYPE: LL-TEX; ISOTYPE: MO).

In the Botanical Museum, University of Copenhagen Herbarium (C), there are six different collections of *A.S. Oersted* 30 made from three different locations (Aguacate, Jaris and Irazú in Costa Rica), between January 1846 and November 1847. In Oersted's original description he states "Frequenter occurrit in Costa Rica, sylvarum humidarum incola, alt. 2,000–5,000. Specimina in montibus Jarvis, Aguacate et Irasu lecta reportavi," without specifying localities further. Mez (1902) and subsequent authors have failed to designate a lectotype. The C sheet of *A.S. Oersted* 30 from Irazú, Costa Rica, of Jan. 1847, is here selected as the lectotype because it is by far the best of the six collections, and has the greatest number of dissections and notes by Oersted associated with it.

The two Lundell species here synonymized represent populations differing only by quantitative characters that are not constant over the range of the species. *Myrsine panamensis* is notable only by the early glabrescent branchlet apices with small trichomes slightly more reddish than other populations of *M. pellucidopunctata*. Populations corresponding to the type of

Myrsine sytsmae are notable only for its narrow leaves, and somewhat shorter petioles. None of these populational characteristics can be consistently used to define taxa and therefore, we relegate *Myrsine panamensis* and *M. sytsmae* to synonymy.

4. ***Myrsine calcarata*** (Lundell) Lundell, *Phytologia* 48:142 (1981). *Rapanea calcarata* Lundell, *Wrightia* 5:295. 1976. TYPE: COSTA RICA. ALAJUELA: S side of Volcán Poás, upper slopes, on road leading past weather station, 24 Mar 1972, *D. Stone* 3141 (HOLOTYPE: LL-TEX).

5. ***Myrsine juergensenii*** (Mez) Lundell, *Phytologia* 48:142 1981. *Rapanea juergensenii* Mez in Engl., *Pflanzenreich* 9 (IV. 236):388. TYPE: MEXICO. Oaxaca: without specific locality, date, *H. Galeotti* 530 (LECTYPE, here designated: US; ISOLECTOTYPES: G, NY).

Rapanea allenii Lundell, *Wrightia* 4:168. 1971. SYN. NOV. *Myrsine allenii* (Lundell) Lundell, *Phytologia* 48:142. 1981. TYPE: PANAMA. CHIRIQUÍ: N forested face of Cerro Copete, an E spur of Chiriquí Volcano, 2,438–2,591 m, 29 July 1947, *P. H. Allen* 4869 (HOLOTYPE: US, LL-TEX-fragment; ISOTYPES: G, MO).

Myrsine chiapensis Lundell, *Phytologia* 58:275. 1985. SYN. NOV. *Rapanea chiapensis* (Lundell) Lundell, *Phytologia* 58:489. 1985. TYPE: MEXICO. CHIAPAS: Municipio of La Trinitaria, E of Laguna Tzikaw, Monte Bello National Park, 1,300 m, 13 May 1973, *D. Breedlove* 35246 (HOLOTYPE: LL-TEX; ISOTYPE: DS, MICH, MO).

Myrsine coclensis Lundell, *Phytologia* 58:275. 1985. SYN. NOV. *Rapanea coclensis* (Lundell) Lundell, *Phytologia* 58:489. 1985. TYPE: PANAMA. COCLE: El Valle, Mesa, 6–6.5 km from Main Street, ca. 1,000 m, 16 Jan 1977, *J. Folsom* 1352 (HOLOTYPE: MO; ISOTYPE: LL-TEX).

Myrsine gillyi Lundell, *Phytologia* 58:276. 1985. SYN. NOV. *Rapanea gillyi* (Lundell) Lundell, *Phytologia* 58:489. 1985. TYPE: MEXICO. NAYARIT: Mirador de Aguila, ca. 14 mi N of Tepic, 450–600 m, 21 Aug 1959, *C. Fedema* 840 (HOLOTYPE: LL-TEX).

Myrsine costaricensis Lundell, *Phytologia* 58:276. 1985. SYN. NOV. *Rapanea costaricensis* (Lundell) Lundell, *Phytologia* 58:489. 1985. TYPE: COSTA RICA. SAN JOSÉ: Along gravel road, 2 km N of Hwy. 12, ca. 10 km W of Interamerican Hwy., 2,200 m, 14 Aug 1977, *T. Croat* 43380 (HOLOTYPE: LL-TEX; ISOTYPE: MO!).

Myrsine jaliscensis Lundell, *Phytologia* 58:277. 1985. SYN. NOV. *Rapanea jaliscensis* (Lundell) Lundell, *Phytologia* 58:490. 1985. TYPE: MEXICO. JALISCO: Sierra de Caule, SW of Talpa de Allende; SW of the prominent peak called Piedra Rajada, S- and W-facing slopes, 2,200 m, 19–21 Nov 1952, *R. McVaugh* 14336 (HOLOTYPE: LL-TEX; ISOTYPE: MICH- n.v., MO).

Rapanea mexicana Lundell, *Wrightia* 5:296. 1976. SYN. NOV. *Myrsine mexicana* (Lundell) Lundell, *Phytologia* 48:142. 1981. TYPE: MEXICO. CHIAPAS: Pico de Loro, near Escuintla, 25 Jun 1941, *E. Matuda* 4228 (HOLOTYPE: LL-TEX; ISOTYPES: A, F, MO, NY, US).

Rapanea reflexiflora Lundell, *Wrightia* 5:297. 1976. SYN. NOV. *Myrsine reflexiflora* (Lundell) Lundell, *Phytologia* 48:142. 1981. TYPE: PANAMA. COCLÉ: Woods adjacent to chicken farm, La Mesa, above El Valle, 3 Jan 1974, *J. Dwyer* 11885 (HOLOTYPE: LL-TEX; ISOTYPES: BRIT, F, MO, PMA).

Mez (1902) cited several specimens, including: *Jürgensen* 326 and 570 (both staminate), *Jürgensen* 338 (pistillate), all from Sierra San Pedro Nolasco; *Cuming s.n.* anno 1859 (staminate), *Ghiesbreght s.n.* anno 1842 (staminate),

and *Galeotti* 530 (pistillate) and 531 (staminate), all from Oaxaca. The bulk of the material was scanty, except for *Galeotti* 530, that had the most complete set of duplicates in the best condition, all of which had been seen by Mez. The US sheet was in the best condition by far, and therefore is selected as the lectotype.

Myrsine juergensenii has heretofore been considered a species of northern Mesoamerica, with a range from Mexico to Honduras. During preparation of the treatment for Flora de Nicaragua, it became obvious that many of the entities described from Panama were actually extreme forms of *Myrsine juergensenii*, either from lower altitudes, isolated mountain ranges, or other habitat extremes. Many of the variations encountered in those populations, as represented by the respective type specimens, also occurred sporadically in populations from Costa Rica, where this species had never been reported before. A series of quantitative variations in the vegetative features of this species' populations and other variations directly attributable to sex expression have given rise to overdescription. For example, the types of *Rapanea allenii* and *M. costaricensis* are notable only for its slightly longer pedicels and calyx lobes slightly narrower than most (but not all) of the *M. juergensenii* populations. The types of *Myrsine chiapensis* and *M. gillyi* are notable only for variation directly attributable to sex expression, such as thicker, shorter sepals, and stouter pedicels than most of *M. juergensenii*'s populations. The yellow-greenish color of the dried leaves in *M. chiapensis* and *M. gillyi* are drying artifacts. Populations corresponding to the types of *Myrsine jaliscensis* and *Myrsine mexicana* differ from those of the average population for the species only by having thinner sepals. Populations corresponding to the type of *Myrsine coclensis* has fewer flowers per fascicle and larger, thicker leaf blades, both features typical of premontane Myrsinaceae, especially those growing in low light regimes. The types of *Myrsine coclensis* and *Myrsine reflexiflora*, collected from the same locality, differ only because they represent staminate and pistillate growth forms of the population, respectively.

6. ***Myrsine cubana*** A. DC., Ann. Sci. Nat. Bot. 16:86. 1941. TYPE: CUBA. Without locality, 1829, *R. de la Sagra* 243 (HOLOTYPE: G-DC).

Sideroxylon punctatum Lam., Tabl. Encyl. 2:42. 1794. *Bumelia punctata* (Lam.) Roem. & Schult. in L., Syst. Veg. 498. 1819. *Myrsine floridana* A. DC., Trans. Linn. Soc. London, Bot. 17:107. 1834, *nom. superfl.* *Myrsine punctata* (Lam.) Stern, Bull. British Mus. (Nat. Hist.), Bot. 4:177. 1969, *non* (H. Lév.) Wilbur, Pacific Sci. 19:522. 1965. *Rapanea punctata* (Lam.) Lundell, Wrightia 4:121. 1969. TYPE: U.S.A. FLORIDA: A. Michaux s.n. (HOLOTYPE: G-DC).

Myrsine veraecrucis Lundell, Phytologia 56:418. 1984. SYN. NOV. *Rapanea veraecrucis* (Lundell) Lundell, Phytologia 58:490. 1985. TYPE: MEXICO. VERACRUZ: Municipio Alvarado, Km 22, Veracruz-Alvarado Hwy., 20 m, 21 May 1977, J. Calzada 3200 (HOLOTYPE: F; ISOTYPE: XAL, n.v.).

Stearn (1969) discovered that the earliest applicable name for this species was *Sideroxylum punctatum* Lam., so he made the combination *Myrsine punctata* (Lam.) Stearn. Unfortunately, that epithet was preoccupied by a combination published in 1966 by Wilbur. Therefore, the next available name is *Myrsine floridana* A. DC. However, A. de Candolle cited *Sideroxylon punctatum* Lam. as a homotypic synonym of *Myrsine floridana*. *Myrsine floridana* A. DC. is a *nomum superfluum*, and the correct name is *M. cubana* A. DC., the oldest available name. In the past, *Myrsine cubana* has been confused with *Myrsine guyanensis* (Aubl.) Kuntze, a South American species from Brazil, the Guianas, and eastern Venezuela. To compound the misinterpretation, Mez (1902) and all subsequent authors have confused *Myrsine guyanensis* (Aubl.) Kuntze with *M. latifolia* (Ruíz & Pav.) Spreng., the latter restricted to the contiguous Andean mountain chain. Pipoly (1992a, 1992b) discussed the diagnostic features separating these three taxa. In addition, Y.B. Harvey & Pipoly (1995) have further elucidated the systematic position of *Myrsine monticola* Martius, a name formerly considered a taxonomic synonym of *M. cubana*.

The type of *Myrsine veraecrucis* is both quantitatively and qualitatively a perfect match to Caribbean populations of *Myrsine cubana* in all aspects. We hypothesize that Lundell's comparison of this species to *Myrsine mexicana* may be responsible for his mistaking the Vera Cruz populations as a new species.

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BOOK NOTICE

CODY, WILLIAM J. 1996. **Flora of the Yukon Territory**. (ISBN 0-660-16406-X, hbk; ISBN 0-660-15898-1, pbk). NRC Research Press, M-55, National Research Council of Canada, Ottawa, Ontario K1A 0R6. \$79.95 (U.S.), hbk. \$49.95 (U.S.), pbk. 643 pp.

Canada's Yukon Territory, about the size of Alabama, Georgia, Mississippi, and Louisiana combined, is a rugged land of mountains (including Canada's highest peak), plateaus, river valleys, and arctic coastal plain. Many botanists have explored and written about the Yukon. The author of this flora has made some 10,000 Yukon collections (probably the most extensive collection of the territory's plants ever assembled and from many previously un- or under-collected areas). Much of Cody's professional life has been spent in pursuit of plants from north of the 60th parallel, with only an occasional excursion into more equable climes. He is eminently qualified to write this opus.

The book is well made and of attractive format. An introduction briefly describes the territory's terrain and vegetation, gives the number of species and genera in each of the Yukon's plant families, and outlines the history of botanical exploration there. Then follow keys to major divisions and families. The main part of the book treats the families in phylogenetic order, with generic descriptions, keys to genera and species (which worked fine for the 20 species I chose as test cases), and well-done generic and specific descriptions. All species are illustrated, the drawings coming mostly from Porsild and Cody's *Vascular Plants of Continental Northwest Territories*. Dot maps show the known Yukon distribution of each species. Completing the book are a glossary, a bibliography, and an index to scientific and common names. A "literature cited" would have been more useful than the "bibliography," most entries of which are not referred to in the main part of the book, thus making difficult a reader's attempts to learn of sources for further reading about the included taxa.

The Yukon flora has 80 families, 339 genera, and 1112 species of vascular plants. Families with more than 100 species (native and introduced) are Poaceae, Cyperaceae, and Asteraceae. These and the rest of the flora are now treated in an up-to-date, well-done, and reasonably priced work. Kudos to Cody.—*John W. Thieret*.

NOMENCLATURAL NOTES AND A SYNOPSIS OF MESOAMERICAN *STYLOGYNE* (MYRSINACEAE)

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ABSTRACT

A nomenclatural summary is provided for the species of the genus *Stylogyne* occurring in Mesoamerica. An updated description of the genus, along with a key to the species is provided. A key to distinguish *Ardisia* and *Geissanthus* from *Stylogyne* is also provided. Five taxa are recognized, including the new combination *Stylogyne turbacensis* subsp. *laevis* (Oersted) Ricketson & Pipoly. All taxa are enumerated, nomenclatural and taxonomic synonyms provided, and six binomials are newly relegated to synonymy.

RESUMEN

Se ofrece un resumen de las especies mesoamericanas pertenecientes al género *Stylogyne*. Se incluye una descripción actualizada del género, acompañada de una clave para identificar las especies. Se ofrece también una clave para distinguir *Ardisia* y *Geissanthus* de *Stylogyne*. Se reconocen cinco taxa, incluyendo la nueva combinación *Stylogyne turbacensis* subsp. *laevis* (Oersted) Ricketson & Pipoly. Se enumeran los taxa, se ofrecen sinónimos tanto nomenclaturales como taxonómicos, y se relegan seis binómenes como nuevos sinónimos taxonómicos.

INTRODUCTION

The neotropical genus *Stylogyne* A. DC. comprises 63 species, of which 7 remain undescribed, owing to lack of adequate material. Understanding the systematic biology of this genus has long been problematic because of its sexual lability. Androdioecious, bisexual, polygamo-dioecious and dioecious species of *Stylogyne* have been documented (Pipoly 1989, 1991), as well as the consequent morphological variation due to sex expression. The genus has often been confused with *Geissanthus* J. D. Hooker (Agostini 1970) and *Ardisia* Swartz, from which it may be readily separated by the following key:

1. Calyx open in bud, the lobes 4–5, free or almost free, dextrorsely (rarely sinistrorsely) imbricate, quincuncial or contorted; corolla lobes dextrorsely (rarely sinistrorsely) imbricate, quincuncial or contorted.
2. Calyx and corolla lobes imbricate or quincuncial; corolla lobes not twisted in bud; ovules mostly pluriserial, or at times appearing uniserial when ovules few in a high anthotactic spiral; inflorescence rachis opaque..... **Ardisia**
2. Calyx and corolla lobes contorted; corolla lobes highly twisted in bud; ovules uniserial or rarely biserial; inflorescence rachis translucent pink to hyaline **Stylogyne**
1. Calyx closed in bud, rupturing irregularly into 2–8 lobes in the same inflorescence at maturity, fused for varying lengths, valvate; corolla lobes valvate or rarely imbricate **Geissanthus**

In preparing a treatment of the Myrsinaceae for Flora Mesoamericana, analysis of the species in the region revealed that the two most commonly known entities, *Stylogyne turbacensis* and *S. laevis*, become inseparable when reviewed over their entire range. The two species, separated by terminal vs. axillary inflorescence in Flora of Guatemala and Flora of Panama (Lundell 1966a, 1971) are now known to overlap significantly in terms of inflorescence position and morphology and occupy different habitats. Therefore, the latter is reduced to subspecific status. Below we provide an emended description of the genus, a key to the Mesoamerican species, and a nomenclator.

Stylogyne A. DC., Ann. Sci. Nat. Bot. 16:78. 1841.

Dioecious, bisexual, androdioecious or polygamo-dioecious *shrubs or small trees*. *Branchlets* mostly glabrous, rarely with simple hairs or translucent lepidote scales on the buds. *Leaves* alternate; blades mostly glabrous; petioles marginate or canaliculate. *Inflorescences* axillary or terminal, rarely axillary and terminal, corymbose or paniculate with the branches racemose or short umbellate-corymbose, sessile or subsessile to long pedunculate, mostly glabrous, rarely with simple trichomes. *Flowers* unisexual or bisexual, corymbose or umbellate, (4-)5-merous, pedicellate; sepals dextrorsely contorted and open in bud, free or short-connate basally, punctate and punctate-lineate, generally glabrous, rarely with simple hairs; petals dextrorsely contorted and highly twisted in bud, short-connate, commonly lineate, punctate and punctate-lineate, mostly glabrous; stamens of staminate and bisexual flowers usually shorter than the petals, the filaments slender, free from each other and adnate to the petals, inserted at petal base or above, the anthers oblong, subsagittate basally, dorsifixed or basifixed, twisted at anthesis, usually dehiscent by latrorse longitudinal slits, rarely first by apical pores then widening by slits; staminodes of pistillate flowers similar to stamens but reduced in size, the antherodes devoid of pollen; pistil of pistillate and bisexual flowers obturbinate, the ovary ovoid, the style long, subequaling

or exceeding the stamens, the stigma punctiform, the placenta ovoid, or globose, basal; ovules 3-5, uni- or rarely biseriate; pistillode of staminate flowers lageniform, the ovary hollow, the style subcapitate, less than 1 mm long. *Fruit* drupaceous, 1-seeded, the endocarp crustaceous or osseous; seed globose or depressed, the endosperm corneous, excavate, not ruminant, the embryo transverse, elongate.

A neotropical genus distributed from Mexico through Mesoamerica, the Andes and Amazonia to SE Brazil, and throughout the Caribbean. In Mesoamerica, there are four species known. In general, members of the genus are infrequently found along watercourses in gallery forests in savannas, in humid, moist, wet or pluvial cloud forests, premontane forests and lowland forests. Members of the genus tolerate very little disturbance and thus, their presence is useful as an indicator of environmental quality.

KEY TO *STYLOGYNE* OF MESOMERICA

1. Leaf blades bullate, minutely puberulent, the margins serrate 1.. *S. hayesii*
1. Leaf blades smooth, glabrous, the margins entire.
 2. Inflorescence axillary, sessile or subsessile, corymbose or racemose.
 3. Inflorescence racemose; pedicels 3–3.5 mm; anthers strictly longitudinally dehiscent; fruits 5.5–6.5 mm in diameter. 2. *S. darienensis*
 3. Inflorescences corymbose, pedicels 0.5-2 mm; anthers dehiscent by pores opening into longitudinal slits; fruits 4.0–5.0 mm diameter 3. *S. glomeruliflora*
 2. Inflorescences terminal and/or axillary, paniculate.
 4. Leaf blades obovate to oblanceolate, subcoriaceous, the punctations conspicuous above; inflorescences pyramidal-paniculate, mostly terminal, or occasionally terminal with few reduced axillary inflorescences 4a. *S. turbacensis* subsp. *turbacensis*
 4. Leaf blades elliptic to oblong, coriaceous, the punctations inconspicuous from above; inflorescences columnar-paniculate, mostly axillary or rarely axillary and terminal or pseudoterminal. 4b. *S. turbacensis* subsp. *laevis*

1. *Stylogyne hayesii* Mez in Engler, *Pflanzenr.* 9(IV. 236):272. 1902. TYPE: PANAMA. DARIÉN: In thick woods, Manmer Station [Manené], Panama Railroad, 15 Oct 1862, *S. Hayes* 662 (HOLOTYPE: G-BOIS; ISOTYPES: BM, K, P).

Distribution and ecology.—Lowland pluvial forests of the Chocó Floristic Province of Panama and Colombia, sea level–600 m elevation.

Stylogyne hayesii is rare in Panama, but extremely common in the Andes, on the western slopes of the Cordillera Occidental at the junction of the Chocó and Antioquia Departments of Colombia. The small, axillary inflorescences and deeply to shallowly serrate leaf margins are distinctive.

2. *Stylogyne darienensis* Lundell, *Wrightia* 5:68. 1974. TYPE: PANAMA. DARIÉN: Slopes of Cerro Chucla, drainage of Río Pavarando, 11 Feb 1972, *A. Gentry* 4261 (HOLOTYPE: LL-TEX; ISOTYPES: BM, MO).

Distribution and ecology.—Lowland wet forest, ca. 100 m elevation, known only from the southeastern Darién of Panama.

3. *Stylogyne glomeruliflora* Cuatrec., Revista Acad. Colomb. Ci. Exact. 8:326. 1951. TYPE. COLOMBIA. VALLE DEL CAUCA: Drainage of Río Digua, Río San Juan, below Queremal, 1,300–1,500 m, 19 Mar 1947, J. Cuatrecasas 23847 (HOLOTYPE: F; ISOTYPE: COL).

Distribution and ecology.—Premontane pluvial forest, 100–1,500 m elevation, Chocó Floristic Province of Panama and Colombia. Inclusion of this species here is the first report for Mesoamerica.

4. *Stylogyne turbacensis* (Kunth) Mez

With the aid of recent collections, most notably from northern Colombian populations, we interpret *Stylogyne turbacensis* to include *S. laevis* because the inflorescence variation virtually eliminates the differences (terminal vs. axillary) used by Lundell (1966a, 1971) to separate them in his treatments of the family for Guatemala and Panama, and necessitating the new combination below. Fieldwork conducted by Pipoly in Nicaragua, Costa Rica, Panama and Colombia has shown that subspecies *turbacensis* tends to be locally common (the individuals clustered) on ridge or hilltops in lowland forests and in premontane forests, while subspecies *laevis* is more equably distributed through lowland wet or humid forests and in gallery forests surrounded by savanna vegetation. We follow the subspecies concept defined by Pipoly (1987), “groups of populations within a single lineage of ancestor-descendant populations that show variation by unique combinations of plesiomorphies, or homoplastic apomorphies, correlated with biogeography and/or ecology. This rank is primarily used to convey information regarding variation in the life histories of these populations and character state differences hypothesized to be the result of this variation. The subspecific rank in no way attempts to predict speciation events.” The differences regarding staminal exsertion indicated in Lundell’s treatment of the family for the Flora of Guatemala and the Flora of Panama treatments are a function of sexual expression, so that in each subspecies, staminate flowers have anthers slightly exserted, while pistillate and bisexual ones have them included in the corolla. On the other hand, pistillate and staminate flowers have long styles on the pistil and pistillode, respectively, while in bisexual flowers, the style is shorter.

- 4a. *Stylogyne turbacensis* (Kunth) Mez subsp. *turbacensis*. *Ardisia turbacensis* Kunth in H.B.K., Nov. Gen. Sp. 3:244. 1818. *Tinus turbacensis* (Kunth) Kuntze, Revis. Gen. Pl. 2:975. 1891. *Stylogyne turbacensis* (Kunth) Mez in Engler, Pflanzent. 9(IV, 236): 270. 1902. TYPE. COLOMBIA. ANTIOQUIA: Near Turbo [Turbaco]. A. von Humboldt & A. Bonpland 1446 (HOLOTYPE: P-BONPL).

Cissus pentandra Willd. ex Roem. & Schult., Syst. Veg. 3:248. 1827. TYPE. COLOMBIA. Without further locality, *Willdenow Herb.* 3005 (HOLOTYPE: B-WILLD, n.v.)

Stylogyne guatemalensis Blake, Contr. U.S. Natl. Herb. 24:16. 1922. TYPE. GUATEMALA. IZABAL: Quebradas, 19–22 May 1919, *H. Pittier* 8624 (HOLOTYPE: US; ISOTYPE: NY).

Stylogyne oaxacana Lundell, *Wrightia* 4:72. 1968. SYN. NOV. TYPE. MEXICO. OAXACA: Distrito de Tuxtepec, Chiltepec and vicinity, 22 m, 12 Jul 1940, *G. Martínez-Calderón* 19 (HOLOTYPE: LL-TEX; ISOTYPES: GH, UC- n.v. US).

Stylogyne perpunctata Lundell, Bull. Torrey Bot. Club 69:398. 1942. SYN. NOV. TYPE. BELIZE [BRITISH HONDURAS]: STANN GRASS CREEK DISTRICT: Silk Grass Creek Reserve, 10 Sep 1939, *P. H. Gentle* 2990 (HOLOTYPE: MICH; ISOTYPES: K, LL-TEX, NY).

Distribution and ecology.—On hilltops or ridgetops of humid lowland tropical forest, to the premontane transition zone, 0–1,000 m elevation; Oaxaca and Veracruz, Mexico, southward through Mesoamerica to Colombia, then southward to Peru and eastward to the Venezuelan Andes.

Populations corresponding to the type of *Stylogyne guatemalensis* are notable only for their widely obovate leaf blades and terminal inflorescence relatively longer than most Mesoamerican populations of subspecies *turbacensis*. *Stylogyne oaxacana* was described largely because of its relatively smaller inflorescence and sepals, and longer style. The type of *Stylogyne perpunctata* has punctations and punctate-lineations more numerous and more brightly orange in color than the average for the subspecies, but is otherwise identical. All these variations overlap and no correlations can be found with ecology or phytogeography.

4b. *Stylogyne turbacensis* (Kunth) Mez subsp. *laevis* (Oerst.) Ricketson & Pipoly, comb. et stat. nov. *Ardisia laevis* Oersted, Vidensk. Meddel. Dansk Naturhist. Fören Kjøbenhavn 1861:125. 1861. *Tinus laevis* (Oerst.) Kuntze, Revis. Gen. Pl. 2:974. 1891. *Stylogyne laevis* (Oerst.) Mez in Engler, Pflanzenr. 9(IV. 236):268. 1902. TYPE. COSTA RICA. CARTAGO: "Monte [Irazú] Irasu, Jan 1847 *A. Oersted* 28 (LECTOTYPE by Lundell (1966b): C).

Ardisia ramiflora Oerst., Vidensk. Meddel. Dansk Naturhist. Fören Kjøbenhavn 1861:125. 1861. *Tinus ramiflora* (Oerst.) O. Kuntze, Revis. Gen. Pl. 2:975. 1891. *Stylogyne ramiflora* (Oerst.) Mez in Engler, Pflanzenr. 9(IV. 236):272. 1902. TYPE. NICARAGUA. ZELAYA: prope Tortuga, Apr 1847, *A. Oersted* 31 (LECTOTYPE by Lundell, 1966b: C).

Ardisia guatemalensis Mez in Engler, Pflanzenr. 9(IV. 236):92. 1902. SYN. NOV., *non Stylogyne guatemalensis* Blake, Contr. U.S. Natl. Herb. 24:16. 1922. TYPE. NICARAGUA. CHONTALES: Acoyapa, 15 Feb 1841, [GUATEMALA. Aioyapa, misinterpreted by Mez], *E. von Friedrichsthal* 857 (HOLOTYPE: W).

Stylogyne reticulata Mez in Engler, Pflanzenr. 9(IV. 236):269. 1902. SYN. NOV. TYPE. COLOMBIA. CAUCA: Near Popayán, *J. Goudot s.n* (HOLOTYPE: P).

Stylogyne nicaraguensis Lundell, *Wrightia* 3:110. 1964. SYN. NOV. TYPE. NICARAGUA. Zelaya: La Esperanza, Río Grande, 0–15 m, 10 Apr 1949, *A. Molina* 2125 (HOLOTYPE: F).

Stylogyne standleyi Lundell, *Wrightia* 3:110. 1964. SYN. NOV. TYPE. PANAMA. CANAL ZONE: Barro Colorado Island in Gatun Lake, less than 120 m, 18–24 Nov 1925, *P. Standley* 41048 (HOLOTYPE: US; ISOTYPE: BM).

Distribution and ecology.—Moist to wet lowland tropical forest and gallery forest in savannas, 0–800 m. Veracruz, Mexico, southward through Mesoamerica to Colombia.

Populations corresponding to the type of *Stylogyne ramiflora* have larger leaves and correspondingly smaller inflorescences, with stamens inserted higher on the petals than the average. Those features are common to staminate plants of the subspecies in scattered locations throughout its geographic range. The type of *Ardisia guatemalensis* is in fruit, and thus, Mez may simply have mistaken it for an *Ardisia* species, because it possesses no other notable feature. Populations represented by the type of *Stylogyne reticulata* Mez are diminutive in terms of inflorescence and leaf size. Populations from the eastern coast of Nicaragua corresponding to the type of *Stylogyne nicaraguensis* are notable only for their prominent orange punctations and punctate-lineations, rather than the more brownish colored punctations and lineations found more commonly throughout the range of the taxon. The type of *Stylogyne standleyi* is notable only for its larger leaves and inflorescences. These variations, uncorrelated with habitat and based mostly on quantitative characters, all overlap when materials are examined throughout the range of the subspecies.

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"The indigenous Chiripá (Guaraní) people of eastern Paraguay maintain ethnic autonomy and economic power through the practice of commercial agroforestry. In this study, Reed investigates the relation of this complex economy to the Chiripá social organization and offers ground-breaking insights into the relations among indigenous groups, nation-states, and the international economy." Contents include: Preface and Acknowledgments; Introduction; Yerba, Society, and the State in Mbaracayú; Kinship, Households, and Community; Leadership and Religion; Chiripá Agroforestry; Patronos, Capataces, and Caciques; Conclusions; Postscript: The Chiripá and Recent Changes; Notes; References; and Index.

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FLORISTIC COMPOSITION OF THE SAN JOSÉ DEL CABO OASIS, BAJA CALIFORNIA SUR, MÉXICO

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ABSTRACT

The wetlands in the Baja California peninsula can be thought of as biological islands because they are surrounded by an arid environment. Also, because of the small area and regular exposure of the wetlands to catastrophic floods, endemic species are rare. The oasis of San José del Cabo is close to the ocean, but the water has relatively low levels of salinity. This oasis is the remnant of a small river that existed at the beginning of this century but which dried up from anthropogenic causes and increasing aridity in the region. Since this oasis is in one of the major tourist developments in Mexico, the aquifer will be affected in the future because of unregulated use to satisfy needs of tourism and of the increasing population. The objective of our study is to document the floristic composition of the wetland to serve as future reference. Our checklist contains 109 taxa of vascular plants. Of these, 78 (71%) are herbs (annuals and perennials). Only 4 (3%) of the taxa are uniformly distributed in the 30 hectares of this study (16 hectares of which are water).

KEYWORDS: Oases, Baja California, Flora

RESUMEN

Los humedales de Baja California Sur pueden considerarse islas biológicas debido a que con sus relativamente elevados niveles de humedad se encuentran rodeados de territorios áridos; sin embargo, debido a la baja superficie que presentan y la exposición a inundaciones catastróficas, su composición florística es pobre en endemismos. El oasis de San José del Cabo se encuentra próximo al mar, pero la intrusión de agua salobre es baja. Este oasis es el último vestigio de un río existente todavía a principios de este siglo, que se secó debido a causas antropógenas e incremento de la aridez en esta región. Debido a que éste se encuentra dentro de una zona de los grandes desarrollo turístico de México, el acuífero que lo abastece será afectado en los años próximos debido a la sobreextracción de agua para satisfacer las demandas del turismo y de la población en expansión. El objetivo del presente estudio es documentar la composición florística actual en este oasis de modo que sirva como referencia para el futuro. El listado anexo comprende 109 taxa de plantas vasculares, de éstas el 78 (71%) son herbáceas (anuales y perennes), pero sólo el 4 (3%) están uniformemente distribuidos en las 30 hectáreas consideradas en este estudio (16 de ellas son de agua).

INTRODUCTION

Baja California Sur is the Mexican state with the least available freshwater. This is because of low rainfall and also the small number of permanent waterways (spring, seeps, pools, rivers, lakes) and reservoirs, some of which are locally called "pozas" or "oases" (Escurra et al. 1988; Grismer and McGuire 1993). Additional causes of the aridity are the predominance of coarse-textured soils that favor water percolation, the high levels of evaporation from the soil, the lack of high mountains, and the narrowness of the peninsula, which provides little surface area for hydrological basins. Some authors, such as Axelrod (1979) and Murphy (1983), suggested an evolving climate on the peninsula. This change has allowed the climate to vary from a mesic subtropical environment through most of the Tertiary to the current xerophytic environment. If true, the oases could be interpreted as relict and disjunct mesic habitats.

The biological relevance of these small areas is in their biotic composition, which can be found only in places with constantly available water, in mesic habitats outside the xeric peninsula, or on mountain tops where temperatures are cooler and precipitation is greater than in the surrounding desert. The social and economical importance of these areas is obvious.

Currently, there are dozens of oases in the peninsula, some of them isolated and others grouped. Some of the best known are San Ignacio (27°25'N, 112°52'W, elev. 150 m), Comondú (26°02'N, 111°49'W, elev. 400 m), La Purísima (26°10'N, 112°07'W, elev. 150 m), Mulegé (26°53'N, 112°02'W, elev. 2 m), Las Pocitas system (around 24°30'N, 111°00'W, elev. 100 to 150 m), and San José del Cabo (23°03'N, 109°41'W, elev. 1 m). Some of these are close to the ocean; others are fed by water from the nearest mountains or by springs. There are no geo-hydrological studies from which to determine their dynamics.

Other wetlands, oases, or estuaries have vanished in the last few decades, some because of water extraction in the hydrological basins to satisfy increasing demands of the local populations. It is possible that the disappearance of wetlands has been exacerbated by the combination of these demands with the natural process of increased aridity in the region (Axelrod 1979; Spaulding and Graumlich 1986). Such wetlands include Todos Santos (23°27'N, 110°18'W, elev. 5 m), Santiago (23°28'N, 109°42'W, elev. 350 m), and Santa Agueda (27°18'N, 112°21'W, elev. 230 m). Other areas may have been wetlands centuries ago, e.g., El Carrizal (23°51'N, 110°10'W, elev. 150 m) and La Ribera (23°34'N, 109°35'W, elev. 10 m).

Lugo et al. (1988) pointed out, in a general classification of these areas, that because of the catastrophic floods and ecological limitations of such environment they have a low species richness, or low β diversity, com-

pared to adjacent habitats. Because of the catastrophic floods, the wetlands also have a relatively young structure. Moreover, they are influenced by certain environmental factors that seem to regulate the structure and other processes in the plant groups. Among these factors are the periodicity of floods and droughts, the kinetic energy of the water, the predominance of the water flux, and the nutrient concentration in the soil. The fundamental niche for each species in the wetlands could be affected to a large degree by water dynamics and nutrient factors.

Cowardin et al. (1979) proposed a hierarchical system of classification for wetlands that was based on water regimen, water chemistry, and soil types. Each oasis can be considered a *palustrine* system if it is less than 2 m deep, or a *lacustrine* system if deeper, if we assume that the water flows slowly and has a small surface area. Using this same classification, these must be designated as “forested wetlands” if palms dominate physiognomically, or as “emergent wetlands” if cattails (*Typha*), reeds, and forbs are dominant.

In addition to the desire to preserve these communities for both ecological and socioeconomic reasons, the study of their plant composition is basic to the proposal of legislation for their use and management.

Vegetation around the San José del Cabo oasis, according the Mexican official chart of vegetation (INEGI 1981), corresponds to the sarcocaulous scrub. Shreve and Wiggins (1964) and Wiggins (1980) recognized this area as a disjointed segment of the Sonoran Desert inside the Cape Region. The oasis is physiognomically dominated by the sky-duster palm, *Washingtonia robusta*, an endemic species occupying riverside and stream banks in the southern half of the peninsula. In the past, this palm probably was widespread inland where moisture in the soil was relatively high. Today, these lands are occupied by abandoned or presently cultivated fields and secondary vegetation. In natural conditions, the ground cover could change dramatically according to the incidence of catastrophic floods, which seem to occur at least once each decade.

Our objective was to compile a floristic list of the higher plants growing in the vicinity of the San José del Cabo oasis. This list can serve as a baseline reference for additional studies seeking to record quality changes in the vegetation over time. The work was a part of a proposal for legislation to designate this community as a protected area. Such a designation was made by state legislation in 1993.

METHODS

During May, July, and September 1993, three trips were made to the oasis to collect plants. The oasis was crossed by foot along its river's edge.

The river consists of a strip of saturated soil of variable width. We estimated a surface of about seven hectares for this area. About 16 hectares of water were traversed by boat to collect aquatic plants.

Specimens collected are housed in the herbarium of the Centro de Investigaciones Biológicas (HCIB). References used for identification were Gould and Moran (1981), Lot et al. (1986), Shreve and Wiggins (1964), and Wiggins (1980). A checklist was devised beginning with our first field trip. It was considered complete after the third trip when no additional species were found. The life form of each species was noted based on the references cited above. Relative abundance was determined by using the density and distribution pattern shown in Table 1. Finally, because adjacent land has been used for intensive agriculture, a proportion of the current flora came from weeds associated primarily with the crops. Using information from the references and voucher specimens collected elsewhere in the state and peninsula, we classified each taxon of the flora as either indigenous or non-indigenous.

DESCRIPTION OF THE OASIS

The San José del Cabo oasis is at 23°04'N and 109°41'W at the southern tip of the Mexican state of Baja California Sur. According to García (1973), the Koeppen climate formula is BW(h')w(e). The climate is very dry and very hot, with a mean annual total precipitation (25 years) of 260 mm. Figure 1 shows the geographic location of the oasis.

The oasis is separated from the ocean (Gulf of California) by a 40 m sandbar. The water level in the oasis is partially regulated by hydrostatic forces of the tides, but intrusion of salt water is small.

The borders of this oasis (and others of the Sonoran Desert) seem to be contracting with the gradual increasing aridity during recent millennia (Van Devender 1990). In addition to depletion of the aquifer, occasional floods from the uplands are sometimes so violent that the oasis is almost swept clean. After such floods, the flora recovers but the conformation of the oasis is altered to some extent. Presently, water covers almost 16 hectares.

TABLE 1. Abundance criteria used for the vascular plants of the San José del Cabo oasis. Value xx has greater dominance (evaluated as frequency, coberture and height) than value x. See appendix.

Population Density	Distribution	
	Regular	Clumped
High	xxxx	xxx
Low	xx	x

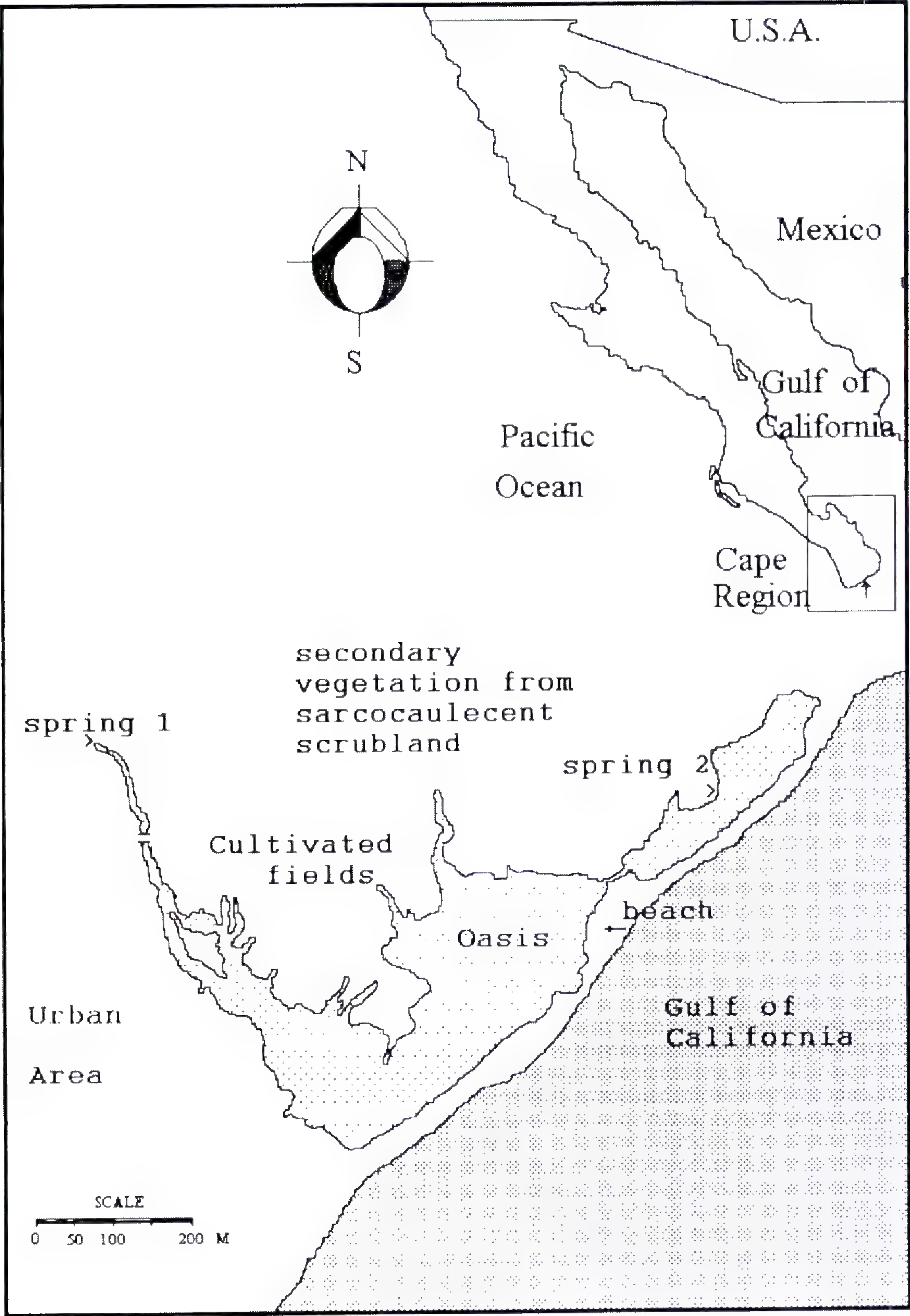


FIG. 1. Geographical location of the San José del Cabo oasis at the southern end of the Baja California peninsula, Mexico (upper). Delimitation of the oasis in relation to its suburbs (lower).

Nelson (1921) noted, in 1905–1906, the existence of the “San José River,” a stream that arose from a spring about 1 km upland and flowed into a freshwater “lagoon” (the current oasis), which supported a flourishing agricultural area of around 300 hectares. The human population, then, was estimated to be 1600. Rice and sugarcane were some of the more prominent crops because of their high water requirements.

Currently, this oasis is in one of the more important tourist developments in Mexico, Los Cabos. There are around 6000 hotel rooms, each with a potential consumption of 400 to 500 liters day⁻¹ when occupied. There is also consumption for domestic purpose by almost 35,000 inhabitants. Reuse of water is highly recommended but not yet developed.

At first, water to satisfy this demand came entirely from wells, all of them in the watershed of the oasis. In 1992 an aqueduct, which gathers the water pumped by several wells, some in agricultural valleys upland, was completed to satisfy requirements of both tourists and inhabitants. It has a flow of 2000 to 3000 liters minute⁻¹. This expenditure is higher than recovery by the aquifer and will inevitably drain it.

CHECKLIST

We did not recognize vegetation types based on physiognomic criteria. Palms, cattails, and reeds have an irregular distribution along the river's edge.

In the attached checklist, each entry is followed by its corresponding life form, abundance, and whether it is native or non-indigenous. Table 2 summarizes the life forms of the 109 taxa of vascular plants of this oasis. Most of them, 78 (71%), are annual or perennial herbs; 13 (12%) are shrubs or trees, and 18 (16%) belong to other life forms.

Table 3 gives the relative abundance of the species of the checklist. Only four (3.6%) taxa have an abundance pattern of high density and regular distribution, marked in the catalog as XXXX; these are *Washingtonia robusta*, *Typha domingensis*, *Bacopa monnieri*, and *Phragmites australis*. Most of the species, 80 (73.4%), show a pattern of low density and regular distribution, marked XX.

There is a notable difference between this oasis and the northern ones in the peninsula. This one has a low number of date palms, *Phoenix dactylifera*, a species introduced into the oases of the peninsula as a food resource by Spanish missionaries in the 16th and 17th centuries. This species survives now as feral groves or with minimal management.

Our work establishes the distribution of several taxa not known before for this latitude on the peninsula, i.e., *Echinodorus berteroi*, *Kosteletzkia depressa*, *Phylla incisa*, *Ruellia inundata*, *Rumex pulcher*, and *Xanthium strumarium*, all known in wetlands from 4° to the north or in those tropical areas.

TABLE 2. Life forms of the vascular plants in the oasis of San José del Cabo, Baja California Sur.

Life forms	No. of taxa	Percentage
Trees (Tr)	4	3.66
Shrubs (Sh)	9	8.26
Perennial herbs (Ph)	41	37.64
Annuals (An)	37	33.93
Hydrophytes + Aquatics (Aq)	7	6.43
Vines (Vi)	10	9.17
Parasites (Pa)	1	0.91
Total	109	100.00

TABLE 3. Classification of the taxa of vascular plants according to their relative abundance in the oases of San Jose del Cabo, Baja California Sur. See Table 1 and appendix.

Abundance	code	number of taxa	percentage
1	(xxxx)	4	3.66
2	(xxx)	8	7.34
3	(xx)	80	73.40
4	(x)	17	15.60
		Σ 109	Σ 100.00

Only 49 (44.9%) of the species in this oasis are natives (in the appendix marked N). The remaining 60 (55.1%) are non-indigenous species indicative of early successional stages or clearly introduced weeds (marked IW) coming from cultivated fields or disturbed areas, such as *Amaranthus fimbriatus*, *Argemone ochroleuca*, *Cynodon dactylon*, *Dactyloctenium aegypticum*, *Datura inoxia*, *Perityle californica*, and *Sida xantii*.

This implies that the wetland has been changed from its original structure. The main sources of disturbances are the agricultural use of the adjacent land, the cutting down of the sky duster palm for support and roofing of rustic “palapas,” and the severe floods regularly affecting the oasis. All these provide niches for species typical of early succesional stages. An additional clue to support this statement is the number of species tied to high levels of humidity (pointed out here as “aquatics” [Aq], of which there are only seven [6.43%]).

Because of the proximity of the ocean to this wetland, one might expect the presence of any of the five mangroves native to the Baja California peninsula, but there are none. For Baja California Hastings et al. (1972) and Wiggins (1980) identified *Avicennia germinans*, the uncommon *Conocarpus erecta*, *Laguncularia racemosa*, the more inland *Maytenus phyllanthoides*, and *Rhizophora mangle*, some of which occur even in higher latitudes in the peninsula up to Bahía de los Angeles at 29°00'N.

A possible explanation for the absence of mangroves in this wetland is given by Alvarez-López (1988) and Lugo et al. (1978). Mangroves grow in warm waters of low kinetic energy with highly predictable cycles. In tropical latitudes, they grow in water with low salinity. In subtropical latitudes, they are linked to highly saline water, a condition not prevailing here.

From the types of freshwater vegetation in Mexico, Rzedowski (1978) cited the "popal," "tular," and "carrizal" as those occurring in hot and temperature climates. These last two are poorly represented in this oasis because of the dominance of, *Phragmites australis*, *Scirpus americanus*, *Typha domingensis*, and other monocotyledons. Floating and submersed species are not dominant here. *Potamogeton* is a widespread aquatic form in the peninsula, but it is absent from the oasis.

CONCLUSIONS

Grismer and McGuire (1993) studied 31 oases in the central Baja California peninsula. Because each has its own physical and biological features, each requires its own characterization. Ezcurra et al. (1988) studied the flora and phytogeography of 17 oases in the hyper-arid zone of the Sonoran Desert, almost all in natural condition. They reported only 26 species of vascular plants, none endemic. Most of these (31%) are taxa distributed in northwestern Mexico and southwestern United States. The hemicryptophytes (perennial herbs with their perennating buds at the soil surface) were the dominant life forms (58%). Felger (1980) studied life forms in several oases of the Sonoran Desert. He found 145 taxa, 54% of them annuals. The life form spectrum found in our checklist is consistent with such results, but dominance of these probably is a sign of disturbance, since 28 of our annuals (73.7%) are considered as introduced weeds.

Rzedowski (1978) indicated, in Mexico, that agricultural and industrial activities and water demand for domestic use have affected aquatic communities more than any other plant community type. The geographic position of San José del Cabo oasis, i.e., within the tropics, and the permanent nature of the water would seem enough to allow a richer flora than that found. Undoubtedly, human disturbance, e.g., clearing of channels, dredging, fumigation against mosquitoes, fires, sewage flow, and cutting down palms have modified the original plant composition drastically, contributing to modification of both composition and structure.

Additional evidence of disturbance in this place is the analysis of the associated fauna. Nelson (1921) quoted for this oasis the endemic rice mouse (*Oryzomys conesi* var. *peninsularis*), which Alvarez-Castañeda (1994) considered to be now extinct.

This oasis is a community which has largely lost its original composi-

tion. Its existence is threatened unless the extraction of water is regulated in its watershed and the water is recycled after treatment for nonpotable use. Today, the oasis is an informal park where tourists go for a stroll. Our report represents one of the last opportunities for studying these special communities of the Baja California and the Sonoran Desert.

ACKNOWLEDGMENTS

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APPENDIX

Annotated checklist of the vegetation of the San José del Cabo oasis, Baja California Sur, México.

Family/Species	L.F.	Abundance	Residence
MONOCOTYLEDONES			
Alismataceae			
<i>Echinodorus berteroi</i> (Spreng.) Fassett MDL 1502	Aq	x	N
Arecaceae			
<i>Phoenix dactylifera</i> L. No Voucher	Tr	xx	IW
<i>Washingtonia robusta</i> Wendell No Voucher	Tr	xxxx	N
Commelinaceae			
<i>Commelina dianthifolia</i> Del. JLL 6094	Ph	xx	N
Cyperaceae			
<i>Cyperus dioicus</i> I.M. Johnston JLL 6116	Ph	xx	N
<i>Cyperus ferax</i> L.C. Rich. JLL 6117	Ph	xx	N
<i>Cyperus pringlei</i> Britt. MDL 1486	Ph	xx	N
<i>Cyperus</i> sp. JLL 6075	Ph	xx	N
<i>Eleocharis parishii</i> Britt. RDC 1729	Ph	xx	N
<i>Scirpus americanus</i> Pers. MDL 1489,RDC 1699	Aq	xx	N
<i>Scirpus californicus</i> (C. A. Mey) Steud. RDC 1723	Ph	xx	N

Lemnaceae

<i>Lemna aequinoctialis</i> Welw. JLLL 6049	Aq	xx	N
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Naiadaceae

<i>Naias marina</i> L. JLLL 6114	Aq	xxx	N
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Typhaceae

<i>Typha domingensis</i> Pers. RDC 239	Aq	xxxx	N
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Poaceae

<i>Arundo donax</i> L. MDL 998, 999	Sh	xx	IW
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<i>Cenchrus ciliaris</i> L. RDC 1706	Ph	xx	IW
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<i>Chloris virgata</i> Swartz MDL 1492	An	xx	IW
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<i>Cynodon dactylon</i> (L.) Pers. No voucher	Ph	xx	IW
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<i>Dactyloctenium aegyptium</i> (L.) Beauv. RDC 1708	An	x	IW
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<i>Digitaria ciliaris</i> (Retz.) Koel JLLL 6090	An	xx	N
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<i>Distichlis spicata</i> (L.) Greene JLLL 6084	Ph	xx	N
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<i>Muhlenbergia microsperma</i> (DC.) Kunth MDL 1479, RDC 1711	An	xx	N
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<i>Panicum purpurascens</i> Raddi RDC 1718	Ph	xx	N
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<i>Paspalum vaginatum</i> Sw. JLLL 6115	An	xx	IW
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<i>Phragmites australis</i> Trin. No voucher	Sh	xxxx	N
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Potamogetonaceae

<i>Ruppia maritima</i> L. MDL 517	Aq	xx	N
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DICOTYLEDONES

Acanthaceae

<i>Elytraria imbricata</i> (Vahl.) Pers. JLLL 6092	Ph	xx	IW
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<i>Ruellia inundata</i> Kuntze JLLL 6091	Ph	xx	N
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Amaranthaceae

<i>Amaranthus fimbriatus</i> (Torr.) Benth. MDL 1478	An	x	IW
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<i>Amaranthus spinosus</i> L. RDC 453	An	xx	IW
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<i>Froelichia interrupta</i> (L.) Moq. RDC 1707	Ph	xxx	IW
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Apiaceae

<i>Apium leptophyllum</i> (Pers.) F. Muell. MDL 1477	Ph	xx	IW
<i>Eryngium nasturtiifolium</i> . Juss. ex Delar JLLL 6121	An	xx	IW

Asclepiadaceae

<i>Cryptostegia grandifolia</i> (Roxb.) R. Br. RDC 1706	Vi	xx	N
<i>Cynanchum palmeri</i> (S. Wats.) S.F. Blake JLLL 6119	Vi	xx	N

Boraginaceae

<i>Coldenia cuspidata</i> I. M. Johnston MDL 1472	Ph	x	IW
<i>Heliotropium curassavicum</i> L. RDC 455	Ph	xx	IW
<i>Heliotropium macrostachyum</i> (DC.) Hemsl. JLLL 6123	Ph	xx	IW

Chenopodiaceae

<i>Atriplex barclayana</i> (Benth.) D. Dietr. subsp. <i>barclayana</i> MDL 1462	Sh	xx	IW
<i>Chenopodium ambrosioides</i> L. RDC 1712	An	xx	IW
<i>Chenopodium murale</i> L. MDL 1469	An	xx	IW

Capparidaceae

<i>Cleome lutea</i> Hook. subsp. <i>jonesii</i> (Tidestr.) Macbr. JLLL 6122	An	xx	N
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Compositae

<i>Ambrosia ambrosioides</i> (Cav.) Payne JLLL 6120	xx An	N	
<i>Ambrosia confertiflora</i> DC. MDL 1497	Ph	xx	IW
<i>Aster exilis</i> Ell. JLLL 6105	An	x	IW
<i>Baccharis glutinosa</i> Pers. RDC 1715	An	xx	N
<i>Bidens aurea</i> (Ait.) Sherff. MDL 1495	An	xx	IW
<i>Conyza bonariensis</i> (L.) Cronquist. MDL 1488	An	x	IW
<i>Eclipta prostrata</i> (L.) L. JLLL 6102	Ph	xxx	IW
<i>Encelia californica</i> Nutt. MDL 1503	Ph	xx	IW

<i>Gnaphalium bicolor</i> Bioletti MDL 1507	An	x	N
<i>Malacothrix xantii</i> A. Gray MDL 995	An	x	N
<i>Perytile californica</i> Benth. RDC 1722	An	xx	IW
<i>Perytile aurea</i> Rose MDL 1509	An	xx	IW
<i>Senecio</i> sp. MDL 1510	Ph	xx	IW
<i>Sonchus oleraceus</i> L. JLLL 6070	An	x	IW
<i>Viguiera tomentosa</i> A.Gray JLLL 6078	Sh	xx	N
<i>Xanthium strumarium</i> L. MDL 1476	An	xx	IW
Cucurbitaceae			
<i>Cucumis dipsaceus</i> Ehrenb. ex Spach. RDC 1719	Vi	xx	IW
<i>Luffa operculata</i> (L.) Cogn. var. <i>intermedia</i> Cogn. ex Rose MDL 1488	Vi	x	IW
<i>Momordica charantia</i> L. RDC 1714, JLLL 6124	Vi	xx	N
Convolvulaceae			
<i>Cuscuta campestris</i> Yunck. MDL 1485	Pa	x	N
<i>Ipomoea</i> sp. JLLL 6110	Vi	x	IW
<i>Merremia quinquefolia</i> (L.) Hallier JLLL 6109	Vi	xx	N
Euphorbiaceae			
<i>Croton californicus</i> Muell.-Arg. ex DC. RDC 1700	Sh	xx	IW
<i>Euphorbia leucophylla</i> Benth. JLLL 6103	Ph	xx	IW
<i>Ricinus communis</i> L. No voucher	Sh	x	IW
Gentianaceae			
<i>Eustoma exaltatum</i> (L.) Griseb. RDC 1703	Ph	xx	N
Labiatae			
<i>Salvia similis</i> Brandegees RDC 1709	Sh	xx	N
Leguminosae			
<i>Cannavalia villosa</i> Benth. MDL 1487	Vi	xxx	N
<i>Crotalaria incana</i> L. RDC 1713	Ph	xx	IW
<i>Neptunia plena</i> (L.) Benth. MDL 1471	Ph	xx	N

<i>Phaseolus atropurpureus</i> Sessé & Moc. MDL 1494	An	xx	N
<i>Rhynchosia minima</i> (L.) DC. JLLL 6106	Vi	xx	N
Loganiaceae			
<i>Buddleja crotonoides</i> A. Gray JLLL 6076	Sh	xx	IW
Lythraceae			
<i>Ammania coccinea</i> Rottb. JLLL 6077	Ph	xx	IW
Malvaceae			
<i>Abutilon incanum</i> (Link) Sweet MDL 1423	Ph	xx	IW
<i>Abutilon</i> sp. MDL 1425	An	x	IW
<i>Gossypium barbadense</i> L. MDL 1505	Sh	xx	IW
<i>Herissantia crispa</i> (L.) Brizicky RDC 1698	Ph	xx	N
<i>Horsfordia alata</i> (S. Wats.) A. Gray JLLL 6079	Ph	xx	IW
<i>Kosteletzkyia depressa</i> (L.) O. Blanch. Fryxell & Gates JLLL 6096	Ph	xx	N
<i>Malvastrum coromandelianum</i> (L.) Garcke MDL 1463	Ph	xx	IW
<i>Sida rhombifolia</i> L. MDL 1434	Ph	xx	IW
<i>Sida xantii</i> A. Gray MDL 1506	Ph	xx	IW
<i>Sphaeralcea ambigua</i> A. Gray var. <i>ambigua</i> A. Gray JLLL 6111	An	xx	IW
<i>Sphaeralcea ambigua</i> A. Gray var. <i>rosaceae</i> (Munz & I.M. Johnston) Kearney JLLL 6080	An	xx	IW
Nyctaginaceae			
<i>Boerhavia coccinea</i> Mill. JLLL 6071	Ph	x	IW
Polygonaceae			
<i>Polygonum hydropiperoides</i> Michx. MDL 1440	Aq	xx	N
<i>Rumex pulcher</i> L. JLLL 6095	Ph	xxx	N
Onagraceae			
<i>Gaura parviflora</i> Douglas ex Hook. JLLL 6118	xx	Ph	N

<i>Ludwigia octovalvis</i> (Jacq.) Raven RDC 1697	Ph	xxx	N
<i>Ludwigia peploides</i> (Kunth) Raven subsp. <i>peploides</i> JLLL 6060	An	xxx	N
Papaveraceae			
<i>Argemone ochrolenca</i> Sweet JLLL 6053	An	xx	IW
Plumbaginaceae			
<i>Plumbago scandens</i> L. MDL 1415	Ph	xx	N
Portulacacaceae			
<i>Portulacca pilosa</i> L. MDL 1429	An	xx	IW
<i>Portulacca oleracea</i> L. MDL 1430	An	xx	IW
Primulaceae			
<i>Anagallis arvensis</i> L. JLLL 6027	Ph	x	IW
Rubiaceae			
<i>Houstonia arenaria</i> Rose RDC 1670	An	x	IW
Salicaceae			
<i>Populus fremontii</i> S. Wats RDC 1728	Tr	xx	N
<i>Salix lasiolepis</i> Benth. MDL 1437	Tr	xx	N
Scrophulariaceae			
<i>Bacopa monnieri</i> (L.) Wettst. JLLL 6124	Ph	xxxxx	N
Solanaceae			
<i>Datura innoxia</i> Mill. MDL 1498	An	xx	IW
<i>Nicotiana glauca</i> R. Graham No voucher	Sh	xx	IW
<i>Nicotiana trigonophylla</i> Dunal JLLL 6066	An	xx	IW
<i>Physalis crassifolia</i> Benth. MDL 1501	An	xx	IW
<i>Solanum nigrum</i> A. Gray MDL 1427	An	xx	IW
Verbenaceae			
<i>Phyla incisa</i> Small JLLL 6101	An	xx	IW
Vitaceae			
<i>Cissus trifoliata</i> (L.) L. JLLL 6125	V1	xxx	N

L. F. = Life Form		Abundance	Residence
Tr.	Tree	(See Tables 1 & 3)	IW = Introduced/Weed
Sh.	Shrub		N = Native
Ph.	Perennial herbs		
An.	Annuals		
Aq.	Aquatics/Hydrophytes		
Vi.	Vines (annuals + woody)		
Pa.	Parasites		
Collectors' names: (All of the specimens are housed at the HCIB herbarium)			
JLL:	José Luis León de la Luz		
MDL:	Miguel Domínguez León		
RDC:	Raymundo Domínguez Cadena		

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CONTRIBUTIONS TO THE FLORA AND ECOLOGY OF THE NORTHERN LONGLEAF PINE BELT IN RANKIN COUNTY, MISSISSIPPI

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ABSTRACT

A study of beech-magnolia forests and adjacent habitats in southern Rankin County, Mississippi, in 1995, resulted in the documentation of twelve species of angiosperms considered rare or imperiled in Mississippi. In addition, populations of several vascular plant species previously known only from localities considerably farther south, either in the southern Longleaf Pine Belt or Coastal Pine Meadows physiographic regions, were discovered during the course of field surveys. The rare or unusual species reported herein from the extreme northern edge of the Longleaf Pine Belt in central Mississippi are *Aster adnatus*, *Hypericum galioides*, *H. setosum*, *Hyptis alata*, *Illicium floridanum*, *Ludwigia linearis*, *Melanthium virginicum*, *Mikania cordifolia*, *Panax quinquefolium*, *Persea palustris*, *Platanthera cristata*, *Pluchea foetida*, *Polygala boykinii*, *Rhaphidophyllum hystrix*, *Sabatia campanulata*, *Schisandra glabra*, *Stewartia malacodendron*, *Triphora trianthophora*, and *Verbesina walteri*. *Iris cristata* is reported as occurring at the southern periphery of its range in Rankin County. The associated plant communities of these taxa are also discussed.

RESUMEN

Un estudio de los bosques de *Fagus grandifolia*-*Magnolia grandiflora* y hábitats adyacentes en el sur del Condado de Rankin, Mississippi, en 1995, dio como resultado la documentación de doce especies de of angiospermas consideradas raras o en peligro en Mississippi. Además, fueron descubiertas poblaciones de varias especies de plantas vasculares previamente conocidas sólo en localidades mucho más al sur, tanto en el sur de las regiones de Longleaf Pine Belt o de Coastal Pine Meadows, durante los muestreos de campo. Las especies raras o poco frecuentes que se citan aquí del extremo norte del Longleaf Pine Belt en Mississippi central son *Aster adnatus*, *Hypericum galioides*, *H. setosum*, *Hyptis alata*, *Illicium floridanum*, *Ludwigia linearis*, *Melanthium virginicum*, *Mikania cordifolia*, *Panax quinquefolium*, *Persea palustris*, *Platanthera cristata*, *Pluchea foetida*, *Polygala boykinii*, *Rhaphidophyllum hystrix*, *Sabatia campanulata*, *Schisandra glabra*, *Stewartia malacodendron*, *Triphora trianthophora*, y *Verbesina walteri*. *Iris cristata* es citado en el extremo sur de su área en el Condado de Rankin. Se discuten también las comunidades vegetales asociadas de estos taxa.

INTRODUCTION

Rankin County is located in central Mississippi, due east of and adjacent to Hinds County, in which the city of Jackson is located (Fig. 1). The southern part of Rankin County is included in the Longleaf Pine Belt physi-

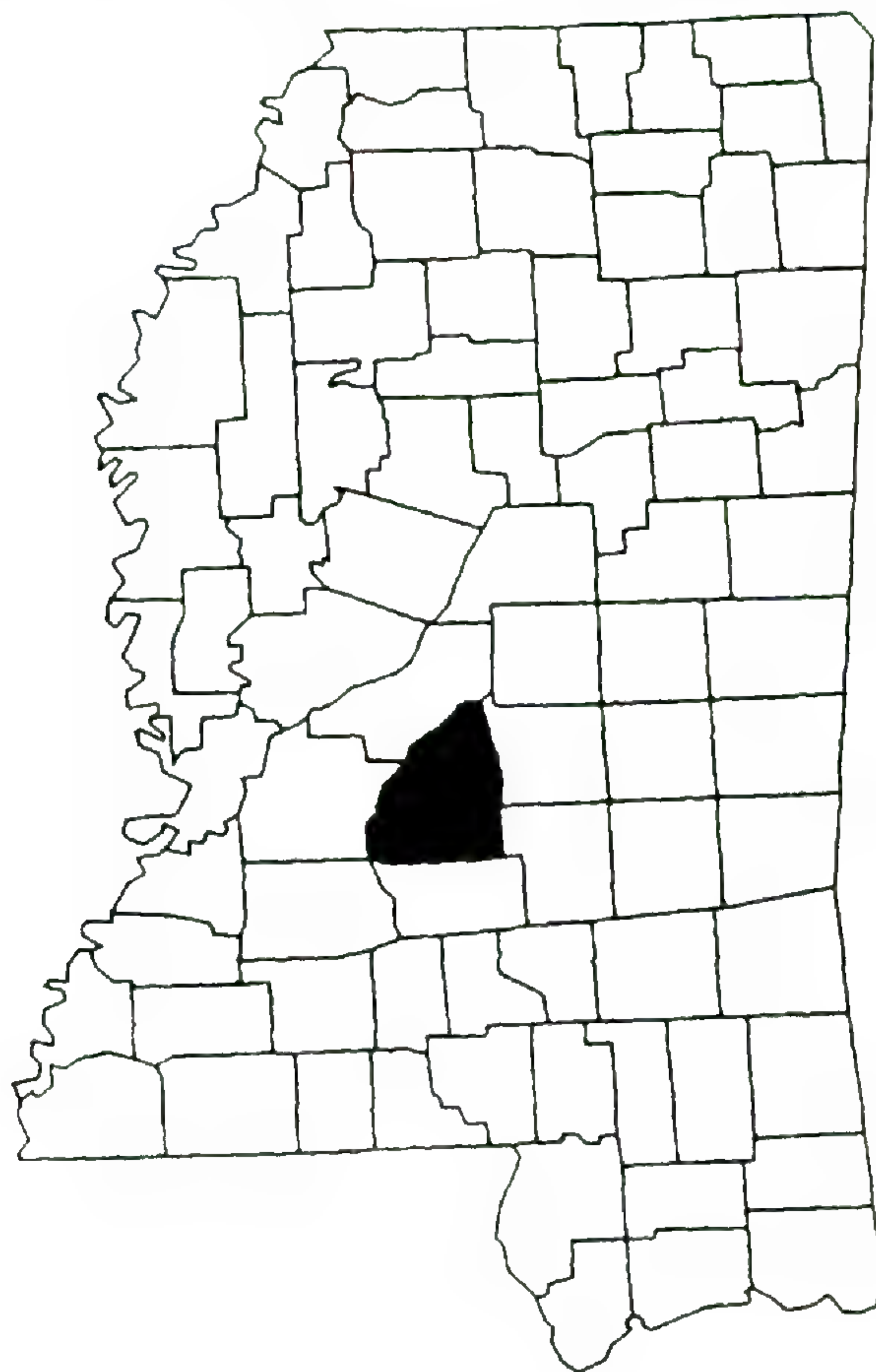


FIG. 1. Location of Rankin County, Mississippi.

ographic region (Lowe 1921). The flora of this area, as well as other areas in the northern Longleaf Pine Belt of Mississippi, is poorly known. Botanical investigations conducted in the southern part of this physiographic region include Harper (1914), Carter and Jones (1968), Mills and Jones (1969), and Rogers (1977); therefore, a considerable body of information concerning vascular plants already exists for that portion of the state. The main purpose of this study was to inventory beech-magnolia forests, referred to as Southern Mixed Hardwood Forests by Ware et al. (1993), and adjacent habitats at the northern periphery of the Longleaf Pine Belt in southern Rankin County, especially for vascular plant species listed as rare or imperiled by the Mississippi Natural Heritage Program (1996). Springs, bogs, and bay swamps at or near the sources of streams and longleaf pine-scrub oak communities on the surrounding ridges were surveyed as well as the Southern Mixed Hardwood Forests. Characteristic species of each community type are listed in Tables 1, 2, and 3. Field work in this area has resulted in the discovery of additional populations of twelve species of plants considered rare or imperiled in Mississippi, as well as new stations for several species at the peripheries of their ranges.

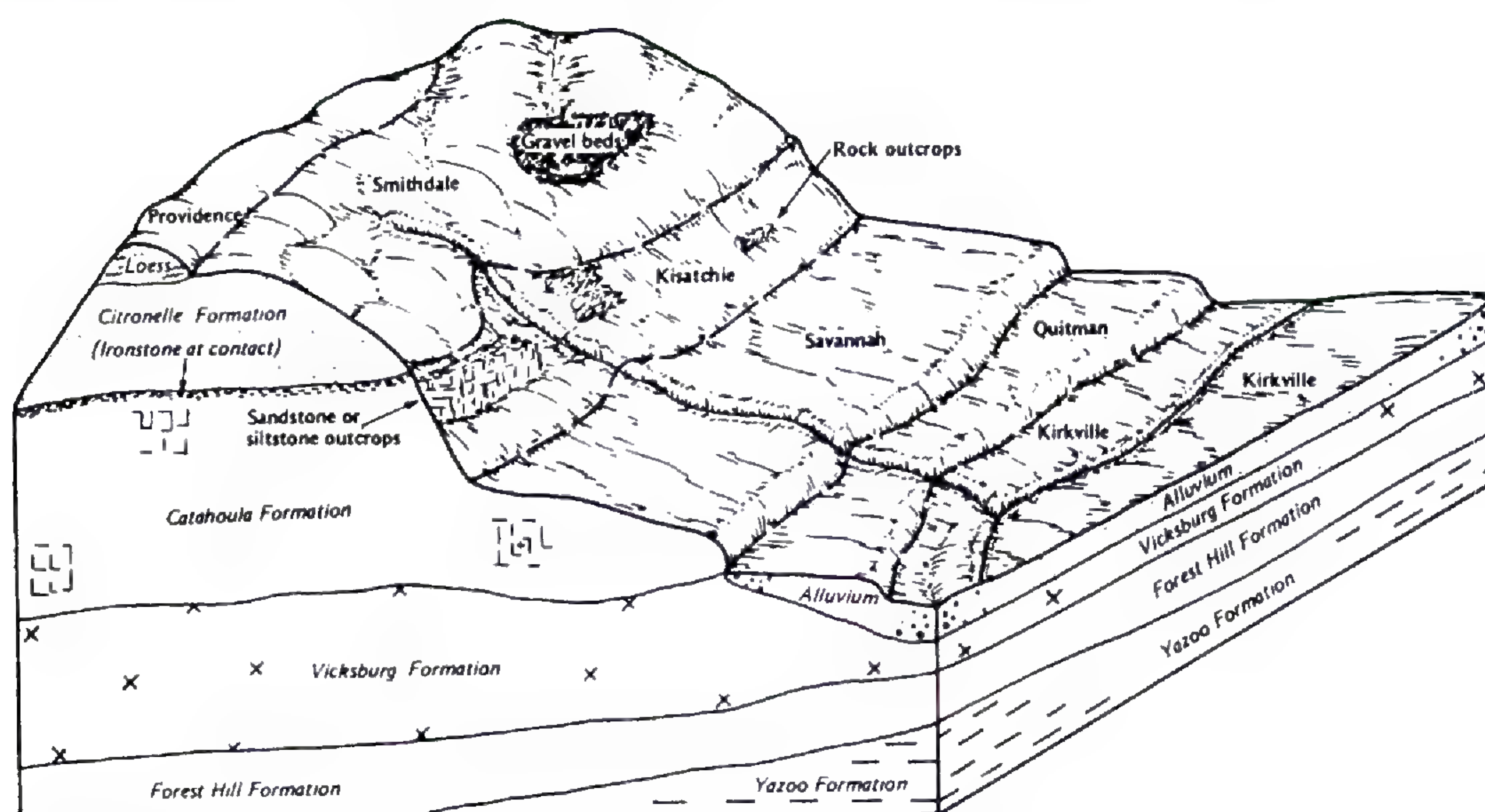


FIG 2. Soils and geologic formations in southern Rankin County, Mississippi.

Soils in the study area are primarily of the Smithdale-Providence-Kisatchie, Smithdale-Providence, Savannah-Quitman, and Quitman-Kirkville associations (Cole et al. 1987). Providence soils are derived from loessial deposits; Smithdale soils are included in the Citronelle Formation; Kisatchie and Savannah soils comprise the Catapoula Formation in this area; and both Quitman and Kirkville soils are classified in the Vicksburg Formation (Fig. 2). According to Cole et al. (1987), Smithdale-Providence-Kisatchie soils are mostly deep, well-drained, medium acid to extremely acid soils on rugged dissected upland with narrow ridgetops, steep hillsides, and short drainageways; they also state that shallow to deep ravines and outcrops of sandstone and siltstone are frequently associated. Permeability is moderate to very slow, available water capacity is moderate to low, and texture ranges from clay to silt, loam, and sand. Smithdale-Providence soils are mostly well-drained, medium to very strongly acid soils on rolling to hilly upland ridgetops and steep hillsides. Permeability is moderate to moderately slow (in the fragipan), available water capacity is moderate, and texture is mostly loamy to silty. Savannah-Quitman soils are mostly deep, moderately well-drained, strongly to very strongly acid soils on gently sloping stream terraces and sloping uplands. Permeability is moderate to moderately slow, available water capacity is moderate, and texture is mostly loamy. Quitman-Kirkville soils occupy nearly level areas on stream terraces and floodplains and are mostly deep, moderately well-drained, strongly acid to very strongly acid soils. Permeability is moderate

to moderately slow, available water capacity is moderate, and texture is usually a fine sandy loam.

Elevation above sea level in southern Rankin County ranges from approximately 220 feet in the floodplain of the Pearl River to about 612 feet on Shiloh Hill (Cole et al. 1987). Both the Pearl River and its tributary, the Strong River, drain this region, and a ridge dividing the two watersheds crosses the area in a southwest-northeast direction.

Due to urban expansion in western Rankin County near the city of Jackson, agricultural practices, and the lumber industry, much of the native vegetation has been drastically altered; however, many sites still exist that are minimally disturbed, especially in areas that are too steep to clear. Southern Mixed Hardwood Forests (beech-magnolia forests) are well-developed primarily in deep ravines, on north- and west-facing slopes and bluffs above streams, and in rich creek bottoms.

The terminology of physiographic regions in Mississippi in the discussion of noteworthy vascular plant species follows Morris (1989) as adapted from Lowe (1921). Other works consulted in the compilation of this paper in addition to those specifically cited in the following discussion include Clewell (1985), Godfrey (1988), and Radford et al. (1968). Herbarium abbreviations follow Holmgren et al. (1990) except MMNS (Mississippi Museum of Natural Science, Jackson, Mississippi), NGC (North Georgia College, & State University, Dahlonega, Georgia), and mwm (Michael Wayne Morris, pers. herb.).

NOTEWORTHY SPECIES

ARALIACEAE

Panax quinquefolium L. Mississippi. Rankin Co.: ca 10 km SE of Star, 25 Aug 1995, *Morris 4484* (MMNS). Ginseng occurs here in rich hardwoods on a gentle, N-facing slope in the relatively flat Dabbs Creek bottom. The species is listed as rare or uncommon in Mississippi (MNHP 1996), and it is found at widely scattered localities mainly in the northern and central portions of the state in the Loess Bluff, North Central Plateau, Interior Flatwoods, Pontotoc Ridge, Black Prairie, Tennessee River Hills, and Jackson Prairie Regions (Morris et al. 1993). It is now known south to Wilkinson, Hinds, Rankin, Smith, and Lauderdale counties (MNHP 1996).

ARECACEAE

Rhapidophyllum hystrix (Pursh) Wendl. & Drude. Mississippi. Rankin Co.: ca 9 km W of Puckett, 26 Aug 1995, *Morris 4497* (IBE, MMNS). Needle palm is classified as rare in Mississippi (MNHP 1996), and this site on the undulating terrace of Campbell Creek is at the northwestern periphery of the species' entire range in the southeastern United States (Clancy 1988). This population consists of one large and two small crowns of the same genetic individual on the upper bank of a large stream near its confluence with Campbell Creek. Rankin County was not included in the total range of needle palm by Clancy (1988).

TABLE 1. Characteristic species of Southern Mixed Hardwood Forests in southern Rankin County.

Overstory	
<i>Acer barbatum</i>	<i>Pinus taeda</i>
<i>A. rubrum</i>	<i>Prunus serotina</i>
<i>Carya glabra</i>	<i>Quercus alba</i>
<i>C. tomentosa</i>	<i>Q. falcata</i>
<i>Castanea dentata</i>	<i>Q. laurifolia</i>
<i>Fagus grandifolia</i>	<i>Q. michauxii</i>
<i>Liquidambar styraciflua</i>	<i>Q. nigra</i>
<i>Liriodendron tulipifera</i>	<i>Q. pagoda</i>
<i>Magnolia grandiflora</i>	<i>Q. shumardii</i>
<i>Nyssa sylvatica</i>	<i>Q. velutina</i>
<i>Pinus glabra</i>	<i>Tilia americana</i>
Understory Trees, Shrubs, and Woody Vines	
<i>Aesculus pavia</i>	<i>Illicium floridanum</i>
<i>Amelanchier arborea</i>	<i>Lindera benzoin</i>
<i>Asimina parviflora</i>	<i>Magnolia macrophylla</i>
<i>A. triloba</i>	<i>Ostrya virginiana</i>
<i>Carpinus caroliniana</i>	<i>Oxydendrum arboreum</i>
<i>Chionanthus virginicus</i>	<i>Prunus mexicana</i>
<i>Cornus florida</i>	<i>Ptelea trifoliata</i>
<i>Erythrina herbacea</i>	<i>Rhamnus caroliniana</i>
<i>Gelsemium sempervirens</i>	<i>Rhapidophyllum hystrix</i>
<i>Halesia diptera</i>	<i>Rhododendron canescens</i>
<i>Hamamelis virginiana</i>	<i>Schisandra glabra</i>
<i>Hydrangea quercifolia</i>	<i>Sebastiania fruticosa</i>
<i>Hypericum hypericoides</i>	<i>Smilax pumila</i>
<i>H. prolificum</i>	<i>S. smallii</i>
<i>Ilex ambigua</i> var. <i>ambigua</i>	<i>Stewartia malacodendron</i>
<i>I. ambigua</i> var. <i>monticola</i>	<i>Styrax grandifolia</i>
<i>I. decidua</i>	<i>Symplocos tinctoria</i>
<i>I. opaca</i>	<i>Vaccinium arboreum</i>
	<i>V. elliotii</i>
Herbs	
<i>Antennaria solitaria</i>	<i>Panax quinquefolium</i>
<i>Arisaema dracontium</i>	<i>Phryma leptostachya</i>
<i>A. quinatum</i>	<i>Polymnia uvedalia</i>
<i>Aristolochia serpentaria</i>	<i>Polystichum acrostichoides</i>
<i>Asclepias variegata</i>	<i>Prenanthes serpentaria</i>
<i>Brintonia discoidea</i>	<i>Sanguinaria canadensis</i>
<i>Chamaelirium luteum</i>	<i>Smilacina racemosa</i>
<i>Desmodium nudiflorum</i>	<i>Spigelia marilandica</i>
<i>Epifagus virginiana</i>	<i>Thelypteris hexagonoptera</i>
<i>Erigeron pulchellus</i>	<i>T. kunthii</i>
<i>Hexastylis arifolia</i>	<i>Tipularia discolor</i>
<i>Isotria verticillata</i>	<i>Trillium cuneatum</i>
<i>Lilium michauxii</i>	<i>Uvularia perfoliata</i>
<i>Matelea carolinensis</i>	<i>U. sessilifolia</i>
<i>Medeola virginiana</i>	<i>Viola affinis</i>
<i>Mikania cordifolia</i>	<i>V. palmata</i>
<i>Mitchella repens</i>	<i>V. walteri</i>

TABLE 2. Characteristic species of seeps, springs, bogs, and bay swamps in southern Rankin County.

Woody Species	
<i>Acer rubrum</i>	<i>Persea palustris</i>
<i>Aronia arbutifolia</i>	<i>Pinus taeda</i>
<i>Cephalanthus occidentalis</i>	<i>Quercus laurifolia</i>
<i>Decumaria barbara</i>	<i>Q. nigra</i>
<i>Hypericum crux-andreae</i>	<i>Rhododendron canescens</i>
<i>Itea virginica</i>	<i>Smilax laurifolia</i>
<i>Lyonia ligustrina</i>	<i>Toxicodendron vernix</i>
<i>Magnolia virginiana</i>	<i>Vaccinium corymbosum</i>
<i>Myrica cerifera</i>	<i>Viburnum dentatum</i>
<i>M. heterophylla</i>	<i>V. nudum</i>
<i>Nyssa sylvatica</i> var. <i>biflora</i>	
Herbs	
<i>Aletris aurea</i>	<i>Lysimachia lanceolata</i>
<i>Aster sericocarpoides</i>	<i>Melanthium virginicum</i>
<i>Bartonia paniculata</i>	<i>Mitreola petiolata</i>
<i>Cacalia ovata</i>	<i>M. sessilifolia</i>
<i>Carex glaucescens</i>	<i>Osmunda cinnamomea</i>
<i>C. lurida</i>	<i>O. regalis</i>
<i>Chasmanthium laxum</i>	<i>Oxypolis rigidior</i>
<i>Cyperus haspan</i>	<i>Panicum microcarpon</i>
<i>Drosera capillaris</i>	<i>Platanthera ciliaris</i>
<i>Eleocharis microcarpa</i>	<i>P. clavellata</i>
<i>E. tuberculosa</i>	<i>P. cristata</i>
<i>Elephantopus nudatus</i>	<i>Pluchea foetida</i>
<i>Eryngium integrifolium</i>	<i>Polygala cruciata</i>
<i>Eupatorium fistulosum</i>	<i>P. mariana</i>
<i>E. perfoliatum</i>	<i>Rhexia mariana</i>
<i>E. rotundifolium</i>	<i>R. virginica</i>
<i>E. semiserratum</i>	<i>Rhynchospora globularis</i>
<i>Fnirena squarrosa</i>	<i>R. glomerata</i>
<i>Gratiola pilosa</i>	<i>R. gracilentia</i>
<i>Hydrolea ovata</i>	<i>R. inexpansa</i>
<i>Hypericum gymnanthum</i>	<i>R. rariflora</i>
<i>H. setosum</i>	<i>Sabatia campanulata</i>
<i>Hyptis alata</i>	<i>Solidago patula</i>
<i>Juncus marginatus</i>	<i>S. rugosa</i>
<i>Lechea minor</i>	<i>Spiranthes praecox</i>
<i>Lespedeza capitata</i>	<i>Viola primulifolia</i>
<i>Liatris spicata</i>	<i>Woodwardia areolata</i>
<i>Linum striatum</i>	<i>Xyris difformis</i>
<i>Ludwigia birtella</i>	<i>X. iridifolia</i>
<i>L. linearis</i>	<i>X. torta</i>
<i>Lycopodium alopecuroides</i>	

TABLE 3. Characteristic species of longleaf pine-scrub oak communities in southern Rankin County.

Woody Species	
<i>Carya pallida</i>	<i>Pinus taeda</i>
<i>C. tomentosa</i>	<i>Prunus umbellata</i>
<i>Castanea pumila</i>	<i>Quercus falcata</i>
<i>Ceanothus americanus</i>	<i>Q. hemisphaerica</i>
<i>Celtis tenuifolia</i>	<i>Q. marilandica</i>
<i>Ilex vomitoria</i>	<i>Q. stellata</i>
<i>Malus angustifolia</i>	<i>Rhus copallina</i>
<i>Myrica cerifera</i>	<i>Toxicodendron toxicarium</i>
<i>Nyssa sylvatica</i>	<i>Vaccinium arboreum</i>
<i>Pinus echinata</i>	<i>V. stamineum</i>
<i>P. palustris</i>	
Herbs	
<i>Agave virginica</i>	<i>Lespedeza birta</i>
<i>Asclepias amplexicaulis</i>	<i>L. stuevei</i>
<i>A. verticillata</i>	<i>Liatris squarrosa</i>
<i>Aster adnatus</i>	<i>L. squarrulosa</i>
<i>A. concolor</i>	<i>Monarda punctata</i>
<i>A. linariifolius</i>	<i>Onosmodium virginianum</i>
<i>Aureolaria pectinata</i>	<i>Pityopsis graminifolia</i>
<i>Bonamia humistrata</i>	<i>Polygala nana</i>
<i>Crotonopsis elliptica</i>	<i>Pteridium aquilinum</i>
<i>Cyperus plukenetii</i>	<i>Sabatia brachiata</i>
<i>Danthonia sericea</i>	<i>Schizachyrium scoparium</i>
<i>Desmodium laevigatum</i>	<i>Seymeria cassioides</i>
<i>Eryngium yuccifolium</i>	<i>Solidago odora</i>
<i>Eupatorium album</i>	<i>Tephrosia virginiana</i>
<i>Gymnopogon ambiguus</i>	<i>Viola pedata</i>

ASTERACEAE

Aster adnatus Nutt. Mississippi. Rankin Co.: ca 3 km SSW of Star, 1 Aug 1995, *Morris* 4390 (IBE). Chainleaf aster is locally infrequent at this locality near sandstone and siltstone outcrops on a longleaf pine ridge. Previously this interesting species was known from sandhills in Jasper (Carraway 1990) and Smith (Lowe 1921) counties and south to the Gulf of Mexico. The Rankin County population extends the documented range of chainleaf aster northwestward in Mississippi by about 70 km.

Mikania cordifolia (L.f.) Willd. Mississippi. Rankin Co.: ca 4 km NE of Puckett, 21 Aug 1995, *Morris* 4459 (IBE, MMNS, NGC, SWSL). Characteristic of bluffs and thickets in rich hardwood forests, this hempweed is considered rare to uncommon in Mississippi (MNHP 1996); and it is present at the northern edge of its range in Rankin County. Otherwise, it is found in Mississippi from Jones County[(Morgan 1979); (2 Aug 1978, *Morgan* 1076, IBE)] in the Longleaf Pine Belt and Claiborne County (MNHP 1996) in the Loess Bluffs southward. Based on herbarium records, the species appears to be most common in the southern Loess Bluff Region. At the Rankin County site, *M. cordifolia* is found in rich hardwoods on the natural levee of Purvis Creek.

Pluchea foetida (L.) DC. Mississippi. Rankin Co.: ca 8 km SW of Johns, 7 Aug 1995, *Morris* 4406 (IBE, NGC). This species is present at the margin of longleaf pine woods in a

seepage area along a gas pipeline. Prior to this collection, *P. foetida* was only documented in Mississippi from Clarke County [(17 Aug 1892, *Boydstrum s.n.*, MISSA); (19 Jul 1967, *Jones 14561 & Jones*, MISS)] to Simpson County (15 Jul 1970, *Jones 19253*, MISS) and south to the coast.

Verbesina walteri Shinnery. Mississippi. Rankin Co.: ca 2 km SE of Puckett, 9 Aug 1995, *Morris 4423* (IBE, NGC). *Verbesina walteri* occurs here at the edge of damp deciduous woods in the floodplain and on the natural levee of the Strong River. This composite appears to be restricted to the shaded margins of moist hardwood forests in the Longleaf Pine Belt in Mississippi from Smith (11 Oct 1968, *Temple 10761*, MISS) and Rankin to Claiborne (Lowe 1921) counties and south to Forrest County (Rogers 1977), except for one curious old record from Tishomingo County in the extreme northeastern corner of the state (Lowe 1921).

CLUSIACEAE

Hypericum galioides Lam. Mississippi. Rankin Co.: ca 6.5 km SE of Brandon, 24 Jul 1995, *Morris 4340* (IBE, NGC). This population is in a seepage area along a stream and constitutes the northernmost record of *H. galioides* in Mississippi. Prior to this collection, the species was documented from Lawrence [(24 Jun 1957, *Ray 8283*, MISSA); (6 Jul 1966, *Jones 7722*, MISS)] to Wayne counties and farther south. Thus, this is a range extension of about 75 km from the nearest locality.

Hypericum setosum L. Mississippi. Rankin Co.: ca 8 km SW of Johns, 28 Jul 1995, *Morris 4363* (IBE, NGC). This St. John's-wort occurs at the margin of longleaf pine woods in a seepage area along a gas pipeline. Previous records of *H. setosum* in Mississippi are from Lawrence (31 Aug 1966, *Jones 9982*, MISS) to Clarke counties and southward. Thus, the Rankin County population extends the species' known range northwestward in the state by about 65 km.

GENTIANACEAE

Sabatia campanulata (L.) Torr. Mississippi. Rankin Co.: ca 8 km SW of Johns, 28 Jul 1995, *Morris 4370* (IBE, NGC). A local, but dense, population of this rose gentian is at the margin of longleaf pine woods in a seepage area along a gas pipeline. Representing a significant range extension in Mississippi, this station is approximately 100 km northwest of the nearest populations in Lamar (27 Jun 1967, *Jones 13616*, MISS), Forrest (Rogers 1977), and Wayne (21 Jul 1955, *Ray 5050*, MISSA) counties.

ILLICACEAE

Illicium floridanum Ellis. Mississippi. Rankin Co.: ca 2.5 km E of Puckett, 14 Aug 1995, *Morris 4439* (IBE, NGC, SWSL); ca 10 km SE of Star, 25 Aug 1995, *Morris 4482* (IBE). The first population of star anise cited here is present in a ridge bottom forest in the floodplain of the Strong River. This ridge bottom is adjacent to several small swampy depressions, and *I. floridanum* locally dominates the understory in the transition area to the depressions. The latter population of star anise occurs in rich hardwoods and around low-lying areas in the undulating Dabbs Creek bottom and also locally dominates the understory. These Rankin County sites are the northwesternmost stations recorded thus far for *I. floridanum* in Mississippi. Elsewhere in the state, it is known from Copiah (29 Apr 1956, *Ray 5468*, MISSA) to Lauderdale (22 Nov 1969, *Clonts 464*, IBE) counties and southward.

IRIDACEAE

Iris cristata Ait. Mississippi. Rankin Co.: ca 3 km E of Star, 17 Aug 1995, *Morris 4445* (IBE). This collection documents the southernmost population of crested dwarf iris known in Mississippi. At this site, *I. cristata* is on the lower slope above a bay swamp in a deep ravine. The very slender rhizomes and relatively broad leaf blades of this *I. cristata* speci-

men helped avoid confusion with *I. verna*, which has much thicker rhizomes and usually more narrow leaf blades. In addition, *I. verna* is only known to occur south and east of Rankin County. The closest voucher specimens of *I. cristata* are from Carroll County in the Loess Bluff Region (16 Apr 1990, *Barbour* 7033, IBE), and Winston (24 Apr 86, *Smith* 1982, IBE) and Kemper (6 Apr 72, *McDaniel* 15863, IBE) counties in the North Central Plateau. Each of these collections is at least 150 km north or northeast of the Rankin County population.

LAMIACEAE

Hyptis alata (Raf.) Shinn. Mississippi. Rankin Co.: ca 10 km W of Puckett, 2 August 1995, *Morris* 4392 (IBE, NGC). Usually found in bogs, flatwoods, wet thickets and clearings (Godfrey & Wooten 1981), musky mint occurs here in a boggy depression at the edge of longleaf pine woods. This is as far north as *H. alata* has ever been recorded in Mississippi. Jones (1976) shows that *H. alata* is mostly distributed from Amite to Greene counties and southward in Mississippi except for one population in Copiah County (4 Aug 1966, *Temple* 3808, MISS), about 60 km southwest of the Rankin County site. There are three additional peripheral populations, one in Covington County about 50 km due southeast of the Rankin County station (30 Jun 1962, *McDaniel* 3265, IBE), and two in Jones County about 85 km distant (21 Aug 1974, *McDaniel* 19180, IBE; 1 Sep 1978, *Morgan* 1178, IBE).

LAURACEAE

Persea palustris (Raf.) Sarg. Mississippi. Rankin Co.: ca 5 km NNE of Johns, 25 Jul 1995, *Morris* 4343 (IBE); ca 9 km SW of Johns, 27 Jul 1995, *Morris* 4355 (IBE, NGC). The first collection was made in a branch bay between ridges with dry longleaf pine woods, and this documentation of *P. palustris* is the most northern record of the species in Mississippi. At this locality, some individuals of swamp bay are at least 7 m in height. The second collection was made from a small 5 m tree in a well-developed bay swamp within Southern Mixed Hardwood Forest. Prior to these records, the documented range of swamp bay in Mississippi was from Simpson (8 Mar 1986, *Stewart* 1780, IBE) and Jones [(*Morgan* 1979); (28 Dec 1978, *Morgan* 1544, IBE)] counties southward to the Gulf Coast.

LILIACEAE

Melanthium virginicum L. Mississippi. Rankin Co.: ca 3.5 km E of Star, 7 Aug 1995, *Morris* 4409 (IBE, MMNS). Considered imperiled to rare in Mississippi (MNHP 1996), Virginia bunchflower is present at this site in a bay swamp at the base of steep, sandy ravines; of 46 plants in this population, 20 had undergone anthesis and were forming capsules. The species is known in Mississippi from the following physiographic regions: Tennessee River Hills (MacDonald 1996), North Central Plateau (Morris 1987, 1988; Winstead 1990), Longleaf Pine Belt (Carter & Jones 1968, Rogers 1977), and Coastal Pine Meadows (MNHP 1996).

ONAGRACEAE

Ludwigia linearis Walt. Mississippi. Rankin Co.: ca 8 km SW of Johns, 30 Jul 1995, *Morris* 4380 & *Morris* (IBE). The population of this seedbox consists of scattered individuals in a low, wet seepage area at the margin of longleaf pine woods along a gas pipeline. *Ludwigia linearis* occurs here at the northwestern periphery of its range in Mississippi. Prior to this study, it was known from Simpson to Lauderdale counties and farther south in the Longleaf Pine Belt and Coastal Pine Meadows, with the exception of two records of the species in Monroe County in the Tennessee River Hills (Jones 1974; MacDonald 1996).

ORCHIDACEAE

Platanthera cristata (Michx.) Lindley. Mississippi. Rankin Co.: ca 10 km SE of Brandon, 31 Jul 1995, *Morris* 4384 (IBE, MMNS). Approximately 105 individuals of this species co-occur with an equally large population of *P. ciliaris* in moist to wet flatwoods along a gas pipeline and adjacent to dry-mesic woods with scattered longleaf pines. Crested fringed orchid is listed as rare in Mississippi (MNHP 1996); favored habitats are pitcher plant bogs, bay swamps, relatively open grass-sedge meadows along spring branches, and wet flatwoods primarily in the eastern and southern portions of the state excluding the Black Prairie and Jackson Prairie regions.

Triphora trianthophora (Swartz) Rydb. Mississippi. Rankin Co.: ca 10 km SE of Star, 25 Aug 1995, *Morris* 4483 (mwm). Three birds orchid is found at this site in Southern Mixed Hardwood Forest on a gentle, N-facing slope in the undulating Dabbs Creek bottom. It is an imperiled to rare species in Mississippi and has been documented only at widely scattered localities in the northern part of the state south to Smith and Clarke counties (MNHP 1996). Rankin is at the southwestern periphery of its range.

POLYGALACEAE

Polygala boykinii Nutt. Mississippi. Rankin Co.: ca 6 km SE of Brandon, 24 Jul 1995, *Morris* 4338 (IBE, NGC, mwm). Growing along the border of upland pine-oak-hickory woods at this locality, *P. boykinii* appears to be restricted to the Longleaf Pine Belt, eastern Jackson Prairie, extreme southeastern North Central Plateau, and southern Black Prairie regions in Mississippi based on herbarium records at IBE, MISS, and MISSA. Thus, with the addition of this collection, the species ranges to Rankin and Hinds (Lowe 1921) counties in the northwest and Noxubee (11 Jun 1966, *Marler* 23, MISS; 14 Jun 1966, *Marler s.n.*, MISS) and Lowndes (Lowe 1921) counties in the northeast.

SCHISANDRACEAE

Schisandra glabra (Bickn.) Rehd. Mississippi. Rankin Co.: ca 10 km SE of Star, 24 Aug 1995, *Morris* 4480 (IBE, MMNS). Scarlet woodbine is very local here, consisting of a population of 8 vines on a rich, well-drained terrace in the Dabbs Creek bottom. This woody vine is rare to uncommon in Mississippi (MNHP 1996). Although known from the Longleaf Pine Belt (Rogers 1977) and the western North Central Plateau (Winstead 1990), *S. glabra* is most common in the Loess Bluffs (Morris 1987, 1988).

THEACEAE

Stewartia malacodendron L. Mississippi. Rankin Co.: ca 11 km SW of Florence, 26 Jul 1995, *Morris* 4348 (IBE, MMNS, NGC, SWSL); ca 9 km SW of Johns, 27 Jul 1995, *Morris* 4353 (IBE, MMNS); ca 11 km ESE of Brandon, 5 Aug 1995, *Morris* 4399 (IBE, MMNS). Silky camellia is a rare to uncommon shrub in Mississippi (MNHP 1996), and these Rankin County populations mark the northernmost known occurrence of the species in Mississippi. Previously, *S. malacodendron* was documented from Copiah to Smith and Wayne counties and southward in the Longleaf Pine Belt (MNHP 1996). The first Rankin County station is an extensive system of rich ravines with many N-facing slopes above Bear Creek; a total of 48 stems, some of which are 5-6 m tall, in four colonies comprise the population of silky camellia here. The northernmost population is on the lower slope of a N-facing ravine on Shiloh Hill, the highest point in the county, and the population southwest of Johns is on a steep, N-facing slope above a bay swamp.

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DOCUMENTED CHROMOSOME NUMBERS 1997.1. CHROMOSOME NUMBERS IN COMPOSITAE FROM MOROCCO AND SPAIN

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ABSTRACT

Chromosome numbers from 18 populations, which represent 14 species (1 represented by 2 varieties) from 11 genera, 4 tribes, of Compositae, confirm reports for the plants.

RESUMEN

Los números cromosómicos de 18 poblaciones, que representan 14 especies (1 con 2 variedades) de 11 géneros, 4 tribus, de Compositae, confirman lo registros para estas plantas.

Although chemical methods increasingly dominate the current vogue, chromosome numbers continue to be important indicators of evolutionary (and taxonomic) relationships among plants (cf. Stebbins 1993).

MATERIALS AND METHODS

Source-plants reported on here were collected and identified by Watson. Voucher specimens have been deposited in the herbarium of Miami University (MU). Chromosome counts were made by Strother from meiotic figures in acetocarmine-stained squashes (in Hoyer's mountant) of sporophytic (pollen parent) cells from floral buds fixed in a solution of 3 parts 95% ethanol: 1 part acetic acid (see Radford et al. 1974; Sharma and Sharma 1980).

RESULTS

Chromosome counts reported here confirm previously reported numbers for the counted taxa (as cited in standard indices, e.g., Goldblatt and Johnson 1996 and references therein).

Anthemideae

Aaronsobnia pubescens (Desf.) K. Bremer & Humphries. $2n = 9$ II. Morocco, S of Geurcif, along Rte. S329 at Fritissa, *Watson* 95-19A.

Anacyclus clavatus (Desf.) Pers. $2n = 9$ II. Morocco, ca. 8 km NW of Ifrane along Rte. S309, *Watson* 95-12C; Spain, SE of Seville at Villaluenga del Rosario, *Watson* 95-29C.

Anacyclus radiatus Loisel. $2n = 9$ II. Spain, NE of Seville, S of Lora del Rio at Guadalquivir River, *Watson* 95-4E; Spain, E of Cadiz at Medina-Sedonia, *Watson* 95-37A.

Anthemis arvensis L. $2n = 9$ II. Spain, SE of Seville at Villaluenga del Rosario, *Watson* 95-29B.

Chamaemelum mixtum (L.) All. $2n = 9$ II. Morocco, along Rte. P24 between Ifrane and Azrou, *Watson* 95-13G.

Chamaemelum nobile (L.) All. $2n = 9$ II. Morocco, between Ito and Azrou, *Watson* 95-14C; Spain, SE of Seville, at Villaluenga del Rosario, *Watson* 95-30B.

Chamaemelum nobile var. *discoidea* (L.) All. $2n = 9$ II. Morocco, along Rte. P24 between Ifrane and Azrou, *Watson* 95-13B.

Chrysanthemum coronarium L. $2n = 18$ (8 II + 2 I, chain of 3 + 7 II + 1 I, etc.). Spain, SE of Seville at Montellano, *Watson* 95-8C.

Chrysanthemum segetum L. $2n = 9$ II. Morocco, along Rte. P24 between Ifrane and Azrou, *Watson* 95-13A.

Cladanthus arabicus (L.) Cass. $2n = 9$ II. Morocco, along Rte. P1 between Oujda and El-Aloun, *Watson* 95-20A.

Glossopappus macrotus (Durieu) Briq. $2n = 9$ II. Spain, S of Seville between Arcos and El Bosque, *Watson* 95-26C.

Otanthus maritimus (L.) Hoffmanns. & Link. $2n = 9$ II. Spain, W of Algeciras at Cabo de Trafalgar, *Watson* 95-36A.

Calenduleae

Calendula incana Willd. subsp. *agarbiensis* (Boiss.) Ohle. $2n = 16$ II. Spain, W of Algeciras between Zahara de Los Atunes and Punta Comarinal, *Watson* 95-34B.

Inuleae

Pallensis spinosa (L.) Cass. $2n = 5$ II. Morocco, NE of Fez at J. Zalagh, *Watson* 95-10C.

Lactuceae

Hypochaeris achyrophorus L. $2n = 6$ II. Morocco, along Rte. S309 ca. 15 km NW of Ifrane, *Watson* 95-11B.

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NOTES

CHAENORRHINUM MINUS (SCROPHULARIACEAE) NEW TO TEXAS

Chaenorrhinum minus (L.) Lange [*Linaria minor* (L.) Desf.], an erect glandular-pubescent annual native to Europe (Fernandes 1972), has long been known as a widespread weed of disturbed and waste places in the eastern United States, particularly in the ballast along railroads (Robinson & Fernald 1908 (as *Linaria*); Fernald 1950; Gleason & Cronquist 1963; Radford et al. 1968; Strausbaugh & Core 1978). It has also been reported relatively far to the west in states such as Missouri (Steyermark 1963) and Oklahoma (Blair 1978; Taylor & Taylor 1994), and from eastern Kansas west to eastern North Dakota (Holmgren 1986). However, it was not included in the Texas flora by Correll and Johnston (1970), Hatch et al. (1990), or Jones et al. (1997).

While working on the forthcoming *Shinners & Mahler's Illustrated Plants of North Central Texas* (Diggs et al.), two Texas collections of *Chaenorrhinum minus* from just south of the Red River border with Oklahoma have become known. One (*Taylor & Taylor* 10570, previously at DUR, now at BRIT) was collected along a roadside in Fannin County in 1972. A more recent collection (*Diggs* 5748, BRIT) was obtained from railroad ballast in Grayson County in 1994. Because of the weedy nature of this taxon and available appropriate habitat, additional Texas records are expected.

The species, which is unusual in having a spurred corolla, can be recognized by the following description: Erect, glandular-pubescent, often branched annual herb with stems to 40 cm tall; leaves opposite below to opposite or alternate above, the blades linear to oblong-lanceolate, 5–20 (–35) mm long, 1–3 (–8) mm wide, entire; flowers in terminal, indistinct, bracteate racemes; pedicels conspicuous, 3–20 mm long in fruit; calyx lobes 2–5 mm long, subequal, linear to linear-spatulate, obtuse; corollas 4.5–9 mm long, pale lavender or lilac with yellow palate, with tube, 2-lipped limb, and a straight, cylindrical, 1–3 mm long spur; stamens 4; capsule 3–6 mm long, porate; seeds numerous; flowering May–July.—George M. Diggs, Jr., Department of Biology, Austin College, Sherman, TX 75090, U.S.A. & Botanical Research Institute of Texas, gdiggs@austinc.edu; Constance E.S. Taylor, R. John Taylor, Southeastern Oklahoma State University, Durant, OK 74701, U.S.A., ctaylor@sosu.edu.

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HYPOCHAERIS GLABRA (ASTERACEAE),
A NEW RECORD FOR TEXAS

Hypochaeris glabra L., a $\pm$ scapose annual native to Europe (DeFilipps 1976), is known in the southeastern United States as far west as Louisiana and Arkansas from disturbed and waste places, especially in sandy soils (Radford et al. 1968; Cronquist 1980; Gandhi & Thomas 1989). However, it was not included in the Texas flora by Correll & Johnston (1970), Hatch et al. (1990), or Jones et al. (1997), nor is it known from Oklahoma (Taylor & Taylor 1994).

While working on the forthcoming *Shinners & Mahler's Illustrated Plants of North Central Texas* (Diggs et al.), a collection of *H. glabra* from a frequently mowed hay field in Williamson Co. in the southern part of North Central Texas (*T.J. Watson 1620*, 1993, BRIT), identified as *H. microcephala* var. *albiflora*, came to our attention. Guy Nesom kindly confirmed our identification of the specimen as *H. glabra*.

Shinners (1966) first documented the occurrence of the genus *Hypochaeris* in Texas following his discovery of the South American *H. microcephala* (Sch.Bip.) Cabrera var. *albiflora* (Kuntze) Cabrera in southeast Texas. Subsequently, two additional species, the Eurasian *H. radicata* L. and the South American *H. brasiliensis* (Less.) Griseb., have been added to the state's flora (Tomb 1974). Keys separating the four *Hypochaeris* species in Texas and the southeastern U.S. can be found in Shinners (1966), Cronquist (1980), and Gandhi & Thomas (1989).

Hypochaeris glabra can be recognized as follows: Annual 10–60 cm tall, usually glabrous or nearly so; stems leafless or only sparsely and minutely bracteate, unbranched or branched; basal rosette leaves numerous, oblanceolate, toothed or pinnatifid; heads 5–15 mm wide; corollas white to yellowish, 1(–1.5) times as long as involucre, only ca. 2 times as long as broad; pappus of an outer series of short, merely barbellate bristles and an inner series of much longer, plumose bristles; outermost achenes usually beakless, the other achenes usually with a well-developed beak. Flowering Feb.–? (in southeastern U.S. flowering mostly in spring, continuing until fall, or almost all year in protected areas) (Shinners 1966; DeFilipps 1976; Cronquist 1980; Gandhi & Thomas 1989).

The genus name has sometimes been spelled *Hypochoeris* (e.g., Shinners 1966; Tomb 1974; DeFilipps 1976), probably based on the spelling by Linnaeus (1754) in *Genera Plantarum*. However, the accepted spelling is *Hypochaeris* (Greuter 1993), based on Linnaeus' (1753) original spelling in *Species Plantarum*.—George M. Diggs, Jr., Department of Biology, Austin Col-

lege, Sherman, TX 75090, U.S.A. & Botanical Research Institute of Texas, gdiggs@austinc.edu; Robert J. O'Kennon, bokennon@brit.org, and Barney L. Lipscomb, barney@brit.org, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102, U.S.A.

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LECTOTYPIIFICATION OF *CLITORIA AUSTRALIS* (FABACEAE)

Bentham (1864) published an Australian flora and in it, newly described was *Clitoria australis* Benth. Currently, the legume treatment of a modern *Flora of Australia* is nearly completed. The objective of this note is to meet a request to provide documentation on the lectotypification of Bentham's species name.

Clitoria australis is an Northern Australian endemic subshrub or suffrutescent herb with both 3- and 1-foliate leaves, small (2.5–3 cm) white flowers, a short, silky pubescent calyx tube (6–8 mm long) with lobes (9–11 mm long) conspicuously longer than the tube, and fruits constricted between the seeds. Fantz (1979) assigned this species to *Clitoria* section *Tanystyloba* Fantz. Other species in this section include *C. cordiformis* Fantz (Thailand), *C. hanceana* Hemsl. (China, Kampuchea, Thailand, Vietnam), *C. javanica* Miq. (Thailand), *C. linearis* Gagnep. (Laos), and *C. macrophylla* Wall. ex Benth. (Myanmar, Thailand, Vietnam).

Bentham (1864) cited one collection of *C. australis* saying "N. Australia. Arnheim S. Bay, R. Brown (Herb. R. Brown). I have been unable to adopt Brown's MS name [= *C. alba*] which is now preoccupied in the genus [= *C. alba* Don, 1832]." I have examined five specimens (E:2 sheets, F:herb. Small, K, NY) of this species collected by R. Brown from Arnheim Bay. They are regarded as original material.

Stafleu and Cowan (1979) reported that Robert Brown's Herbarium came into possession of J.J. Bennett in 1858, and was later split upon the latter's death in 1876, with collections going to BM, K and E. Bentham examined these specimens after his revision (Bentham 1858) of *Clitoria* that lacked *C. australis*, but prior to his publication in 1864. Presumably, the specimens were examined when they were part of Bennett's Herbarium. No specimen has been located at BM.

Two specimens (E-108¹, K) bear a printed label citing "R. Brown, Iter Australiense, 1802-1805. [Presented by direction of J.J. Bennett, 1876]." Label data included "Arnheim S. Bay," a collection number of 4237, and "*Clitoria alba*" R. Br. (Robert Brown's name) with "*C. australis*, Benth." written on the label below Brown's name. The remaining three specimens (E-109, F, NY) lacked the Bennett label, Brown's species name and collection number, but were distributed with Bentham's species name. The E-109 specimen had the same locality and date, whereas the F specimen bore

¹Specimens from E lacked accession numbers. Cited are the accession numbers found below 60/74 [loan number] in the center of an inked circular stamp with "Royal Botanical Gardens, Edinburgh" around the margin.

only "Australia, 1802-5" and the NY specimen bore only "Australia, Arnheim S. Bay."

In selecting a lectotype, the F and NY were excluded immediately from consideration, as they lacked the Bennett label, Brown's manuscript name *C. alba*, and complete label data. In addition, these two specimens appear somewhat distinct in appearance to me from the other three specimens, in the age of the flowers, color of vegetative parts, and in overall stature. It seems probable to me that this pair of specimens were collected on different dates, are not true duplicate collections of the specimens (*Brown 4237*) deposited at E and K, and possibly not even examined by Bentham.

Of the remaining three specimens, the K specimen was designated as the lectotype. It is a good representative specimen of the species, agrees closely with the diagnosis by Bentham, bears Brown's name and the specific locality name discussed in the protologue, and was annotated by Bentham. Bentham (1864) did not cite Brown's collection number, but Bentham (1858) has used this practice previously when he described other species of *Clitoria* (e.g. *C. flagellaris*, *C. nana*). Location of these types revealed a collector's number not cited by Bentham in the protologue. The F and NY specimens are probable original material, but are not regarded by me as duplicates of the lectotype collection; therefore, they were annotated as lectoparatypes instead of isoelectotypes. In conclusion, the citation for this species is as follows:

***Clitoria australis* Benth.**, Fl. Austral. 2:242. 1864. [*Clitoria alba* R. Brown, *nom. in sched.*, non Don (1832)]. TYPE: AUSTRALIA. NORTHERN TERRITORY: Arnheim S. Bay, 1802–1805, *R. Brown 4237* (LECTOTYPE, designated here: K-J.J. Bennett herb.; ISOELECTOTYPES: E-108¹ & 109). AUSTRALIA. I.C., *R. Brown s.n.* (LECTOPARATYPES: F-Hb. Small, NY).

—*Paul R. Fantz, Dept. of Horticultural Science, Box 7609, North Carolina State University, Raleigh, NC 27695-7609, U.S.A.*

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NAMING A SOUTHWESTERN MALAXIS (ORCHIDACEAE)

Recently, Coleman (1997) brought to my attention the fact that Watson (1883) had described a specimen collected in Arizona by the Lemmons, naming it *Microstylis purpurea*. Ridley (1888) revised *Microstylis* and *Malaxis*. Since Lindley (1849) had used the specific epithet *purpurea* to describe a *Microstylis* from Ceylon and Java, Ridley renamed the taxon *Microstylis porphyrea*. In this revision, he rejected the idea that the taxon was the same as *M. ebrenbergii*. Ridley's comment was "*M. porphyrea* has no distinct fovea; the lip is concave at the base but not saccate." This latter refers to Reichenbach's (1849) description of the lip of *M. ebrenbergii* as "gibbere acuto in medio parte basilari," i.e. acutely gibbous in the middle basal part. Kuntze (1891) placed all *Microstylis* species under *Malaxis*, so the taxon became *Malaxis porphyrea* (Ridl.) Kuntze. In their consideration of *Malaxis* nomenclature, Ames and Schweinfurth (1935) decided that *M. porphyrea* was synonymous with *M. ebrenbergii*, and subsequent authors have followed their lead (e.g., Correll 1950; Luer 1975 et al.).

I have examined the holotype of *M. porphyrea* from the Gray Herbarium. It has papillate floral segments and narrowly sagittate lip which easily differentiate it from *M. ebrenbergii* with glabrous floral segments and a broadly triangular-hastate lip. The species should be listed as follows:

Malaxis porphyrea (Ridley) Kuntze., Rev. Gen. Pl. 2:673. 1891. *Microstylis porphyrea* Ridl., J. Linn. Soc., Bot. 24:320. 1888. *Microstylis purpurea* S. Watson, Proc. Amer. Acad. Arts 18:195. 1883, non *Microstylis purpurea* Lindl. TYPE: U.S.A. ARIZONA. Cochise Co.: Tanner's Canyon, Hyachuca Mts., Jul 1882, J.G. & S.P. Lemmon 2881 (HOLOTYPE: GH).

There is a difference that appears in Ridley's and Reichenbach's descriptions that has not been considered in previous justifications for separation of the two species. Ridley states the stem to be "superne laxe racemosus," i.e., loosely racemose above. Reichenbach, in contrast, says, "racemus plurimiflorus," i.e., raceme very many flowered. This difference is readily seen in Figures 1 and 2, where each dorsal sepal is about 2 mm long.

The ranges of the two do not overlap. The southernmost sites of *M. porphyrea* are probably in northern durango and Sonora. The northernmost site of *M. ebrenbergii* is in southern Hidalgo. The gap between is about 1200 km.

ACKNOWLEDGMENTS

I am grateful to the Curator of the Gray Herbarium for the expeditious loan of a holotype specimen and thank all the friends and colleagues who have provided comments and suggestions.



FIG. 1. *Malaxis porphyrea*. New Mexico.
Photo by T.K. Todsén.



Fig. 2. *Malaxis ebrenbergii*. Oaxaca, Mexico.
Photo by E.W. Greenwood.

—*Thomas K. Todsén, Department of Biology, New Mexico State University, Las Cruces, NM 88003, U.S.A.*

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BOOKS NOTICES

SMITH, BRUCE D. 1995. **The Emergence of Agriculture**. (ISBN 0-7167-5055-4, hbk.). W.H. Freeman and Company, 4419 West 1980 South, Salt Lake City, UT 84104, U.S.A. (801) 973-4660, (801) 977-9712 FAX. \$32.95. 230 pp, numerous b&w, color photos, and maps.

From the cover: "In *The Emergence of Agriculture*, well-known archaeologist Bruce Smith explores the initial emergence and early expansion of agriculture, and the transformations in human society that it made possible. Archaeologists have come to recognize that agriculture didn't just emerge in one or two places, from whence it spread to others, but was independently invented several times over, in widely separated parts of the world. In his book, Bruce Smith charts the course of the agricultural revolution as it occurred in the Middle East, Europe, China, Africa, and the Americas, showing, too, how basic archaeological methods and modern technologies such as plant analysis, radiocarbon dating, and DNA sampling are used to investigate this pivotal event. Although in the popular mind the agricultural revolution is often seen as a one-step transition from hunter-gatherer societies to farming ones, Smith shows how truly varied were the patterns of animal and plant domestication in different parts of the world." Contents include: Preface; In Search of Origins; Creating New Plants and Animals; New Technology and the Search for Agricultural Origins; The Fertile Crescent; Europe and Africa; East Asia; Middle and South America; Eastern North America and the Southwest; Epilogue: The Search for Explanations; Further Readings; Sources of Illustrations; and Index.

VENTOCILLA, JORGE, HERACLIO HERRERA, and VALERIO NUNEZ (Edited by Hans Roeder, translated by Elisabeth King). 1995. **Plants & Animals in the Life of the Kuna**. (ISBN 0-292-78725-1, pbk; 0-292-78726-x, hbk.). University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819, U.S.A. 512-471-4032. \$12.95 (pbk.), \$25.00 (hbk.). 160 pp, 5 b&w photos, 33 line drawings, 3 maps.

"The earth is the mother of all things...' begins this original and accessible book on how the Kuna Indians of Panama relate to the natural world. An integrative project involving Kuna traditional leaders and trained scholars, and fully illustrated by a Kuna artist, this translation of *Plantas y animales en la vida del pueblo Kuna* focuses on Kuna plant and animal life, social life, and social change as a means of saving traditional ecological knowledge and 'returning' it to the community." Contents include: Foreward by James Howe; Acknowledgments; Baba's Creation; Ready to Change; The Kuna; Rivers and Mountains; Terrestrial Fauna; Hunting in Gangandi; Money Creates Hunger; Submarine "Deforestation;" The Spirit of the *Uaga*; Medicinal Plants; The *Ueruk* Palm; To Be or Not to Be; Epilogue; Appendix A. (Scientific and Vernacular Names of Plants and Animals); Appendix B. (Kuna Communities); Glossary; Bibliography; Authors; and Index. The book is nicely illustrated.

REHM, S., EDITOR. 1994. **Multilingual Dictionary of Agronomic Plants.** (ISBN 0-7923-2970-8, hbk.). Kluwer Academic Publishers, 101 Philip Drive, Norwell, MA 02061, U.S.A. \$120.00. 286 pp.

From the Preface and Introduction: "This dictionary contains the names of nearly 2500 plant species, in some cases including subspecies and varieties. Tropical crops from all parts of the world receive the same attention as those from the temperate zone. Common names are given not only in English, French, German, Portuguese and Spanish but also in many other languages, where such names are used in the technical literature.

'Agronomic plants' comprise not only the agricultural and horticultural crops but also pasture plants, green manure, soil covers, trees used in agroforestry, and major weeds. Purely ornamental plants have been excluded. Also included are plants which are presently being discussed as new crops, with considerable economic value.

The *Dictionary* includes five languages: English, French, German, Portuguese, and Spanish. The dictionary will meet the needs not only of scientists in agriculture, botany and geography but also those of agricultural extensionists, merchants in agricultural products and professional translators."

HUNTER, MALCOLM L. JR. 1995. **Fundamentals of Conservation Biology.** (ISBN 0-86542-371-1, hbk.). Blackwell Science, 238 Main Street, Cambridge, MA 02142, U.S.A. (617) 876-7000, (617) 876-7022 FAX. \$42.95. 482 pp, numerous b&w illustrations.

From the cover: "The book focuses on what can be done to maintain biodiversity through management of ecosystems and populations. Starting with a succinct look at what conservation and biodiversity really mean and progressing to more complex topics such as mass extinctions, habitat degradation, and over-exploitation, Hunter creates a context in which the principles of conservation biology can be readily understood. Discussions of the social, political, and economic aspects of conservation biology issues are interwoven throughout the text and addressed independently in their own chapters. With a careful eye towards providing coverage that is balanced geographically, taxonomically, and environmentally, Hunter provides a superlative book that sets the standard in this increasingly important subject." Contents include: Preface; Conservation and Conservation Biology; What is Biodiversity; Species Diversity; Ecosystem Diversity; Genetic Diversity; Mass Extinctions and Global Change; Extinction Processes; Habitat Degradation and Loss; Over exploitation; Exotic Species; Managing Ecosystems; Managing Populations; Zoos and Gardens; Setting Priorities; Social Factors; Economics; Politics and Action; Epilogue; Literature Cited and Author Index; Species Index; and Subject Index.

BOOK REVIEWS

DON E. WILSON AND ABELARDO SANDOVAL (eds) MANU. 1997 **The Biodiversity of Southeastern Peru; La Biodiversidad del Sureste del Perú.** (ISBN 1-56098-710-3, pbk). Smithsonian Institution Press, 470 L'Enfant Plaza, Washington, DC 20560. \$35. 679 pp. Numerous figures, maps. and b/w plates.

This volume of 26 articles by 93 authors and collaborators represents an up-to-date summary of the inventory protocols, flora, and fauna present in the Manu MAB Biosphere Reserve. Located in the Departments of Cusco and Madre de Dios, the area comprises over 1.5 million hectares tropical forest, and has been the site of intensive field biological research since 1987.

The book is divided into three sections: General floristics, flora and fauna. The general floristics not only provides a detailed summary of what is known regarding the vegetation, but a detailed explanation of the sampling protocol employed. The floristic section includes two articles dealing with the mapping and inventory protocols used by the BIOLAT and Smithsonian/MAB office of Biodiversity Programs. These are articles written in an extremely clear style and will be standard references for a long time to come. The Flora section contains seven articles, ranging from topics dealing with forest dynamics, family accounts (Chávez, Londoño, Herrera), and finally a report on the bryoflora (Gradstein). All are first-class treatments, written in a very straightforward, easily usable style, and are exhaustive in their coverage. Finally, the Fauna section contains two subsections, invertebrates (8 articles) and vertebrates (12 articles). The invertebrate section is dominated by entomological and arachnological studies, pointing to the need for studies of other invertebrates, such as annelids, and mollusks. The vertebrate section contains ichthyological, herpetological, ornithological, and mammalogical studies, with one study of a dipteran.

Among the papers of the invertebrate subsection, the Silva & Coddington paper on the spiders, and the Morales & McDiarmid paper on amphibians, are particularly notable because of their statistical rigor, relevance to the floristics section, and their foci on comparative analyses with other areas of Peru. The paper on genetic diversity of amphibians, by Córdova et al. is particularly timely and provides baseline data critical for monographers to consider because karyotypic diversity within one general area is discussed.

In summary, this volume is a timely and clearly written summary of our knowledge of the biological diversity present in this mammoth Biosphere. It will not only provide baseline data for the taxonomic groups treated, but will provide fodder for many a grant proposal and the protocols, so clearly explained, make it an excellent choice for a biodiversity measuring and monitoring course. The editors are to be congratulated on still another fine product, and the two program directors involved, Dr. Wilson of the Smithsonian Biodiversity Programs office, and Dr. Dallmeier of Smithsonian/MAB, are to be commended for an outstanding example of long-term collaboration. At \$35 for cloth, and less for paper, the book is more than a bargain.—*John J. Pipoly III, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

KELLER, ROLAND. 1996. **Identification of Tropical Woody Plants in the Absence of Flowers and Fruits** (ISBN0-8176-5184, pbk). Birkhauser-Verlag, P. O. Box 133, CH-4010 Basel, Switzerland. \$69.95.

This book is the result of careful field observations by Keller in Venezuela, Madagascar, and Indonesia and to a lesser extent, in French Guiana, Guadeloupe, and Cameroon. Its principal purpose is to facilitate identification of sterile or juvenile woody plant specimens (living or, with greater difficulty, herbarium) to the familial or hopefully, generic level.

I have tested this book with taxa from Colombia, Ecuador, Peru, the Guianas, Philippines and Papua New Guinea, and can unequivocally state that it is, indeed, a handy reference work. I was able to find only one glaring omission, that of the lianous genus *Embelia* (Paleotrop.) in the Myrsinaceae. It should key out opposite the Annonaceae entry, in Key T, page 71, with a couplet as follows: "Bark not aromatic. Plant not twining, starting out as a scandent shrub, later maturity into liana, without hooks." Apart from confusing portions of Key X (couplet 13 in particular), the 26 keys are clear and easy to follow. The specialized Keys, composed of X, Y and Z are particularly helpful and desperately needed.

The selection of families is wide and reasonable. I would have added the Clethraceae and Gesneriaceae, because of their great importance in such regions as the Western Cordillera of Colombia and adjacent Ecuador, the Amazonia/Hylaea interface of Ecuador and Peru, and Eastern Malesia (especially New Guinea).

The Glossary, Notes and Illustrations section comprises 59% of the book's bulk. Section 1, "geographical distribution", is essentially a list of important woody families from each area conforming to the author's categories. Sections 2-20 comprise an illustrated glossary, which is very good. I would have rephrased Section 6 because my understanding of sympodial branching is that it occurs by either substitution or apposition. Whether the resultant branches are plagio- or orthotropic does not affect the process of sympodial branching, but describes the final resultant branches orientation. Thus, e and f on page 6 should have the word "sympodial" added in front of the terms apposition and substitution, respectively. Perhaps that can be further clarified in the next edition of the book. In Section 7, I see little difference between continuous and diffuse ramification. I suggest that any perceived difference between the two is strictly spatial and not morphogenetic. I think the same thought process applies to the Location of the ramification on the unit of extension, which I have found to be quite variable in highly dynamic forests (with many windstorms, etc.). Also, it would have been helpful to remind the reader who is not fluent in architectural terminology about differences between monoaxial and polyaxial systems in monocaulous trunks. This is often a point of confusion, and it bears repeating in Section 7. From there, in Section 16, I would have preferred to seen a line or two about ptyxis vs. vernation in vegetative organs, but the examples here from Cullen are quite good. For Venation, Section 17, I would have preferred more close adherence to the standards proposed by Hickey in the *Anatomy of the Dicotyledons*, 2nd ed., Vol I. The same comment would hold true for the chapter on trichomes of the same volume, here included as Section 20.

Part II, "Principal families of tropical woody Dictyledons..." is extremely useful for many families, but needs the following corrections:

f: leaf with linear lyso-schizogenous canals (punctate-lineations), rather than leaf with resiniferous ducts,

g: leaf with hydropotes , instead of underside of blade with glandular trichomes inserted at the bottom of small cavities.

The author is to be commended for successful completion of a Herculean task. Doubtless, there will be groups other than those mentioned in the forward that have slipped by him, but on the whole, there is no other resource like this book. While I have pointed out but a few suggestions, I highly encourage all tropical ecologists, dendrologists, agronomists and systematists to buy this book and put it to the test in their area of geographic specialty. If the community can respond constructively and the minor corrections made, this field guide will be a truly unique standard for everyone's use.

The paper is high quality, as well as the binding. While my copy is already dog-eared, the spine has survived quite well. Its price is somewhat prohibitive, but its usefulness makes it a bargain, given its utility. I unhesitatingly recommend it for everyone.—*John Pipoly III, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

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INTRODUCTION

The grass genus *Erioneuron* was described by Nash in Small (1903) based on *Erioneuron pilosum* (Buckl.) Nash. Species of this genus have been placed in several genera that are discussed in Valdés-Reyna (1985) and Peterson et al. (199?). *Erioneuron* and *Dasyochloa* species were submerged in *Tridens* for many years (Parodi 1934; Hitchcock 1913, 1951; Gould 1951). Tateoka (1961), in a study of *Tridens* presented cytological, morphological, and anatomical evidence to support recognition of two distinct genera. Based on these results Tateoka recognized the genus *Erioneuron* with five species, and suggested affinities with the genus *Munroa*, rather than with *Tridens*. That classification was accepted by agrostologists and used in several grass floras (Correll & Johnston 1970; Nicora 1973; Gould 1968, 1975, 1979; Anton 1977; McVaugh 1983; Zuloaga et al. 1994).

The genus *Dasyochloa* Willd. first appeared in Steudel (1840) as a synonym of *Uralepis*. Two species of *Dasyochloa* were listed, *D. avenacea* Willd. and *D. pulchella* Willd., both as “*nomina nuda*.” Although Rydberg (1906) validated *Dasyochloa* with an English description as part of a key, it has been regarded as a synonym of *Erioneuron*. Caro (1981) transferred the species of the genus *Erioneuron* (excluding *E. pilosum*) to *Dasyochloa*, based on the lemma morphology. Sánchez (1983) studied *Dasyochloa* reporting that anatomical information formed the most important differences between *Erioneuron* and *Dasyochloa*. She accepted *Dasyochloa* as a monotypic North American genus, consisting of *D. pulchella* Willd. ex Rydberg.

Anatomical characters of both leaf epidermis and leaf blade cross section were reported by Valdés-Reyna and Hatch (1995) and support the conclusions of this study. *Dasyochloa* has U-shaped leaf blades and sclerenchyma that are well-developed in association with the vascular bundles. *Erioneuron* leaf blades are V-shaped and the sclerenchyma strands are absent or few in association with the vascular bundles.

Enzyme electrophoresis can help delimit the occurrence of what appeared to be intermediates within the *E. avenaceum-pilosum* complex. Suspected natural hybridization between these species has raised the question concerning relationships. In addition, electrophoretic information may be important for the acceptance or rejection of the monotypic North American genus *Dasyochloa* (Caro 1981; Sanchez 1983).

MATERIAL AND METHODS

Plant materials were obtained from field locations in the southern United States and northeastern México from 1983 to 1993. Plants were also grown from seed in the greenhouse. Samples of 10 plants per site were collected from 60 naturally occurring populations. Field notes were taken for each population sample concerning location, growth habit, general appearance,

A REVISION OF *ERIONEURON* AND *DASYOCHLOA* (POACEAE: ERAGROSTIDEAE)

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ABSTRACT

A taxonomic treatment of the New World genera, *Erioneuron* and *Dasyochloa*, is presented. Materials for morphological, electrophoretic and anatomical studies were collected from naturally occurring populations, and from herbarium specimens throughout the range of the species. A morphological analysis of specimens from 60 populations of *Erioneuron* and *Dasyochloa* is given. Phenetic and basic biostatistical techniques were used to delineate and define taxa. Based on these results four species were defined. An electrophoretic survey was conducted on seedlings representing 33 natural populations. Individuals were assayed for five enzyme systems: PGI, GOT, IDH, PGM, and MDH. The results show that variation at the molecular level is concordant with the morphological characters for the separation of taxa. Based on these studies and anatomical data three species of *Erioneuron* are recognized and a lectotype is designated for *E. pilosum*. This research supports the recognition of *Dasyochloa* (*D. pulchella*) as a monotypic North American genus.

RESUMEN

Se presenta un estudio taxonómico de los géneros del Nuevo Mundo *Erioneuron* y *Dasyochloa*. Los materiales para los estudios morfológicos, electroforéticos y anatómicos fueron tomados de poblaciones naturales y de ejemplares de herbario en todo el rango de distribución de las especies de estos dos géneros. Fue realizado un análisis morfológico de muestras de 60 poblaciones. Fueron usadas técnicas fenéticas y bioestadísticas básicas para delimitar y definir los taxa. Basados en los resultados fueron definidos cuatro grupos. Fue realizado un muestreo electroforético en plántulas que representan 33 poblaciones naturales. En los individuos fueron analizados cinco sistemas enzimáticos: PGI, GOT, IDH, PGM, y MDH. Los resultados muestran que la variación al nivel molecular es concordante con los caracteres morfológicos para la separación de los taxa. Basados en estos estudios se reconocen tres especies de *Erioneuron*, se designa el lectotipo de *E. pilosum*. Esta investigación apoya el reconocimiento de *Dasyochloa* (*D. pulchella*) como un género monotípico para Norteamérica.

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TABLE 1. Abbreviations for the 46 characters used in phenetic analysis. Level of accuracy, binary state (BS) and multistate (MS) characters are given.

Character	Abbreviation	Accuracy
Vegetative		
Stolon	STL	1.0 cm
Culm height	CUH	1.0 cm
Culm diameter	CUD	0.1 mm
Culm nodes vertiture	NOV	MS
Culm vestiture	CUV	MS
Leaf sheath length	LSL	1.0 mm
Leaf sheath margin vestiture	SMV	MS
Leaf sheath collar vestiture	SCV	0.1 mm
Leaf ligule length	LLL	0.1 mm
Leaf blade length	LBL	1.0 mm
Leaf blade width	LBW	0.1 mm
Leaf blade adaxial vestiture	ADV	MS
Leaf blade abaxial vestiture	ABV	MS
Leaf blade folded or involute	LBF	BS
Leaf blade cartilaginous margins	BCM	MS
Leaf blade base vestiture	LBV	MS
Inflorescence		
Inflorescence length	INL	1.0 cm
Inflorescence width	INW	1.0 mm
Nodes per inflorescence	INN	MS
Spikelets per branch	SPB	MS
Inflorescence color	INC	BS
Inflorescence position	INP	BS
Spikelet		
Spikelet lenght	SPL	0.1 mm
Number of florets/spikelet	NFL	MS
First glume length	FGL	0.1 mm
Second glume length	SGL	0.1 mm
Lemma length	LLE	0.1 mm
Lemma awn length	LAL	0.1 mm
Lemma cleft length	LCL	0.1 mm
Lemma base vestiture	LBP	MS
Lemma margin vestiture	LMP	MS
Lemma lateral awns	LLA	BS
Lemma lateral nerves	LNL	0.1 mm
Palea length	PAL	0.1 mm
Palea vertiture	PAP	MS
Spikelet pedicel vestiture	SPP	MS
Anther length	ANL	0.1 mm
Caryopsis length	CAL	0.1 mm
Caryopsis width	CAW	0.1 mm
Ratios		
Inflorescence length/width	RINF	—
First glume length/spikelet length	RFGS	—
Second glume lenght/spikelet length	RSGS	—
First and second glume/spikelet lenght	RAGS	—
Lemma cleft length/lemma length	RLEC	—
Lemma awn length/lemma length	RLAL	—

time of flowering, soil type, elevation, date, and associated species. Information on population variation, species variation, and flowering characteristics was recorded at each site. Field collections were supplemented by herbarium specimens obtained on loan from the following major herbaria: A-GH; ANSM; ARIZ; BAF; BRIT; COCA; COLO; CORD; ENCB; MEXU; MICH; MO; NMC; NY; SAT; SD; TAES; TEX-LL; US; WYAC. Voucher specimens collected during this study are deposited at ANSM and TAES.

Several populations were collected by collaborators and used in this study. Herbarium specimens obtained from Argentina that were not collected specifically for this study were used as a "real population." These artificial populations were assigned different numbers to distinguish them from other populations in the phenetic analysis.

Phenetic Analysis of Populations.—Populations were collected and identified in the laboratory prior to the phenetic analysis and observations made on the variation for a number of characters. Forty six characters (Table 1) were identified that appeared to show variation among specimens. Sixteen vegetative characters, six from the inflorescence, eighteen spikelet characters, and six derived ratio characters were measured.

As the characters were measured, each specimen and population were given an *a priori* symbol. This was done because certain multivariate techniques (e.g. MANOVA) require the use of *a priori* designations for analysis. These symbols were given according to certain morphological characters which are listed below.

- A = Specimens with slender wiry stolons, blade involute, inflorescence not well-exserted, spikelets in leafy fascicles (*Dasyochloa pulchella*).
- B = Specimens with inflorescences long exserted, blades conduplicate, lemma acuminate, entire or with a notch 0.1–0.5 mm deep (*E. pilosum*).
- C = Specimens with lemma truncate with a notch 1.0–2.5 mm deep (*E. avenaceum-pilosum* complex).
- D = Specimens similar to "C" except with the lemma awn longer than the lobes, the spikelets 10–15 mm long (*E. avenaceum-grandiflorum* complex).
- E = Specimens similar to "C" except with the lemma awn scarcely longer than the lobes, the spikelets less than 10 mm long (*E. avenaceum-nealleyi* complex).

Two methods were used to analyze the variation present among the morphological characters. Statistical Analysis System (SAS) [Ray 1982] was used to provide basic statistical data and to perform discriminant analysis. The Numerical Taxonomy System of Multivariate Statistical Programs (NT-SYS) [Rohlf et al. 1980] was utilized to provide Principal Components Analysis (PCA) and Cluster Analyses were performed with UPGMA and distance matrices.

All populations were analyzed using univariate methods to determine groupings and relationships within the taxa, and for selection of characters to be used in multivariate analyses. Cluster analysis and principal components analysis were used to compare all populations.

Electrophoretic Analysis.—Materials for this study were obtained by germinating seeds harvested from individual plants from 33 naturally occurring populations, from across the geographic range of this genus in North America. A total of 285 individuals were assayed. Table 2 lists the localities where the populations were collected.

The electrophoretic sample consisted of crude homogenate tissue from the three uppermost leaves taken from the seedlings grown under artificial light. Starch gels were formed in 22.5 cm × 15.5 cm × 0.8 cm plastic molds similar to those described by Cardy et al. (1980). Two buffer systems were used. Buffer system I consisted of a Tris (0.083M)/citric acid (0.005M) gel buffer (pH 8.7) and an electrode buffer (pH 8.1) of 0.3M boric acid and 0.056 sodium hydroxide. Gels used with system I were of a 8.8% starch (Connaught) concentration.

Buffer system II consisted of a histidine (0.004M)/citric acid (0.0005M) gel buffer (pH 6.5) and an electrode buffer (pH 6.5) of 0.0064M histidine and 0.0008M citric acid. Gels used with system II were of a 10% starch concentration. Filter paper wicks (12 mm × 2 mm - Whatman #3) containing homogenate from each machine-ground sample of leaf tissue were inserted in gels of both buffer systems, 30 samples per gel were examined.

Gels were run at 30mA and 250v for buffer system II, and 30mA and 100v rising to 250v for buffer system I. The wicks were removed after 30 minutes. Electrophoresis continued for a total of six hours. Two slices were taken from buffer system I, and three slices from buffer system II. Those taken from buffer system I were stained for the enzymes PGI (phosphoglucisomerase), and GOT (glutamate-oxaloacetate transaminase). Buffer system II was stained for IDH (isocitrate dehydrogenase), PGM (phosphoglucumutase), and MDH (malate dehydrogenase).

In order to obtain a quantitative measure for genetic interpretation of the phenotypes observed in these species, and to provide a better understanding of allozyme variation, observational data were taken from routine electrophoretic screens of the taxa. These data included the occurrence and frequencies of isozyme phenotypes. The phenotypes were coded as qualitative multistate characters and the NT-SYS package of Rohlf et al. (1980) was employed to perform Cluster Analysis (UPGMA), and PCA.

From these analyses, a taxonomic classification of both genera is presented.

RESULTS AND DISCUSSION

Phenetic Analysis.—Characters for which there were a high accounting

TABLE 2. Specimens of *Erioneuron* and *Dasyochloa* used for electrophoretic analyses, listed by species, country, state, collector, and collection number. Specimens are deposited at ANSM and TAES.

Erioneuron avenaceum (H.B.K.) Tateoka

MEXICO: COAHUILA: La Noria, *Valdés-R.* 1568. SAN LUIS POTOSÍ: Guadalcazar, *Valdés R.* 1641, Enrique Estrada, *Valdés-R.* 1694, 1695; 10 mi S of San Luis Potosí, *Valdés-R.* 1697, 1698.

Erioneuron grandiflorum (Vasey) Tateoka

MEXICO: COAHUILA: Saltillo, *Valdés-R.* 1507, 1544. NUEVO LEÓN: El Salero, *Valdés-R.* 1623, 1627.

UNITED STATES: TEXAS. Presidio Co.: *Valdés-R.* 1687.

Erioneuron nealleyi (Vasey) Tateoka

MEXICO: COAHUILA: Saltillo, *Valdés-R.* 1455, 1531, *Hatch* 5015. Durango; Poanas, S. *González* 2812, 2792. NUEVO LEÓN: El Salero, *Valdés-R.* 1620. TAMAULIPAS: Bustamante, *Valdés-R.* 1655.

UNITED STATES: TEXAS. Presidio Co.: *Valdés-R.* 1689.

Erioneuron pilosum (Buckl.) Nash

MEXICO: COAHUILA: Saltillo, *Valdés-R.* 1502, 1701. NUEVO LEÓN: Arroyo Mojaras, *Valdés-R.* 1632. SAN LUIS POTOSÍ: Enrique Estrada, *Valdés-R.* 1695.5.

UNITED STATES: NEW MEXICO. Grant Co.: *Valdés-R.* 1681. TEXAS. Briscoe Co.: M.C. *Johnston s.n.* Jim Wells Co.: C. *Coffey* 599. Kimble Co.: C. *Coffey* A-17, 425.

Dasyochloa pulchella (H.B.K.) Willd. ex Rydb.

MEXICO: COAHUILA: Saltillo, *Hatch et al.* 5055*a*. SAN LUIS POTOSÍ: Enrique Estrada, *Valdés-R.* 1696. ZACATECAS: Concepción del Oro, *Valdés-R.* 1611.

UNITED STATES: TEXAS. Presidio Co.: *Valdés-R.* 1688, 1691.

(50%) of interspecies variation were STL, CUH, NOV, LSL, LBW, ADV, ABV, LBF, BCM, INL, INN, SPB, INP, LCL, LLS, LLA, RFGS, RSGS, RAGS, RLEC, RLAL (Table 1).

A number of characters not mentioned in previous treatments are contributed to explain the variation on the PC axes. These include CUD, LBL, LBP, and ANL. A principal component analysis of 60 populations shows a clear separation of all populations of group A (Fig. 1). The first two components account for 55.5% of the variation present in this first analysis (31.9 and 23.6 percent of trace, respectively). Specimens of group A are small plants of usually not more than 10 cm tall. A phenogram derived from a correlation of all populations is presented in Figure 2. Group A is separated from the rest of the groups morphologically.

The remainder of the populations analyzed are shown in Figure 3, two clusters are observed, although without a clear separation. The small cluster corresponds to populations of group E. The other cluster corresponds to a complex of groups B, C, D, and some E. Group E was fairly distinct as a separate cluster. The major characters accounting for variation were size, spikelet characters, and the ratios. Groups B, C, and D appeared to form a continuum in their variation with no clear discontinuity between populations.

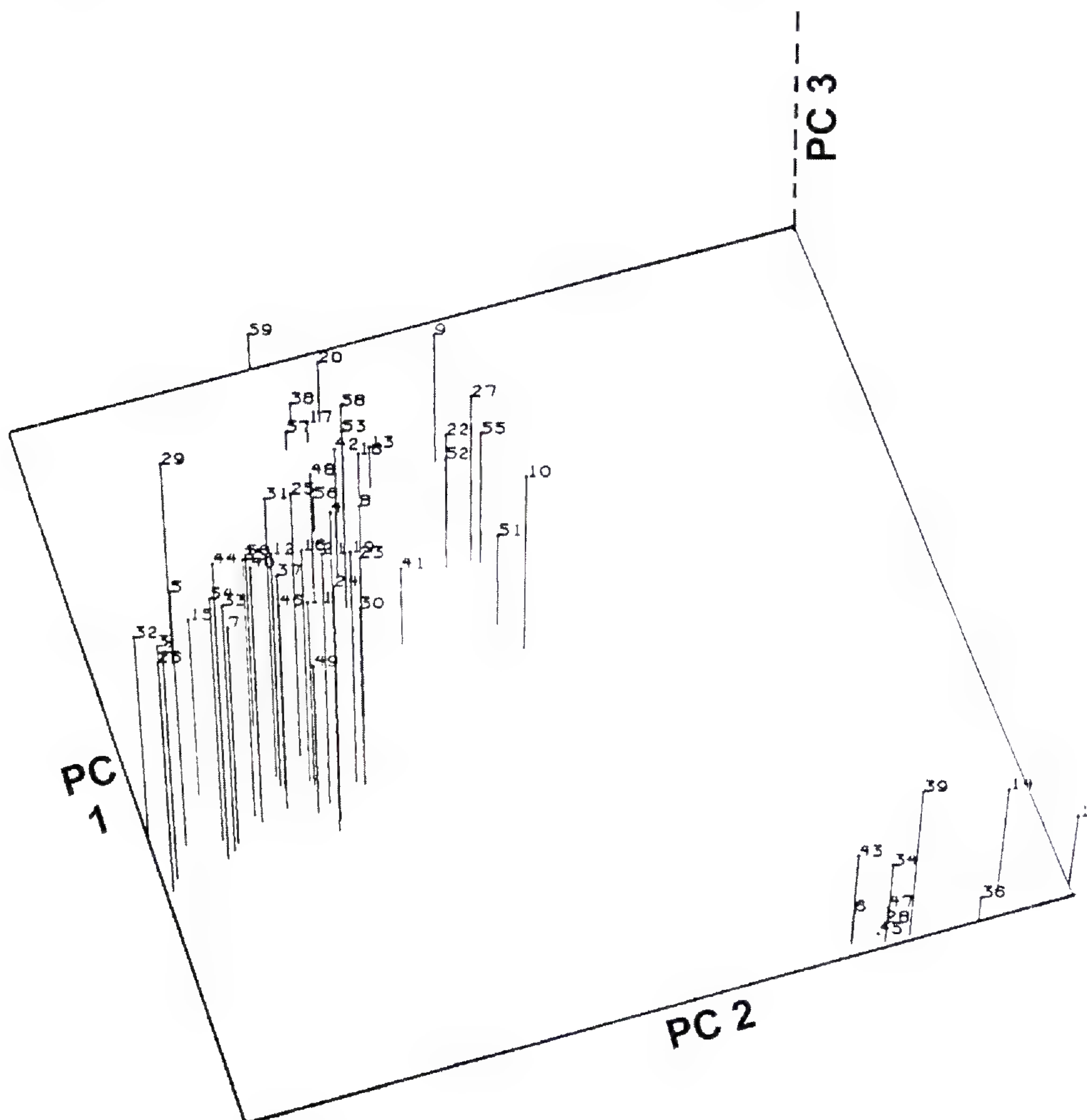


FIG. 1. Principal components analysis of all populations in *Erioneuron sensu lato*. The cluster of populations removed to the right of the main group represents group A (labeled 1, 6, 14, 28, 34, 36, 39, 43, 45, 47).

These results estimate the overall variability among the species and indicates groupings based on morphological similarities. Group A, which represents *Dasyochloa pulchella*, can be separated distinctly from the rest of populations, which represent the genus *Erioneuron*. Groups B, C, and D cannot be consistently separated on the basis of morphological characters. In general specimens of group B and C tend to be separated, on some instances, on the basis of lemma awn and lemma cleft length. However, hybridization is suggested along a continuum of morphological variation given the presence of group D which represents *E. grandiflorum*. Groups B and C represented *E. pilosum* and *E. avenaceum* respectively, and in some instances these taxa can be differentiated. However, intergradation is suggested. Group E,

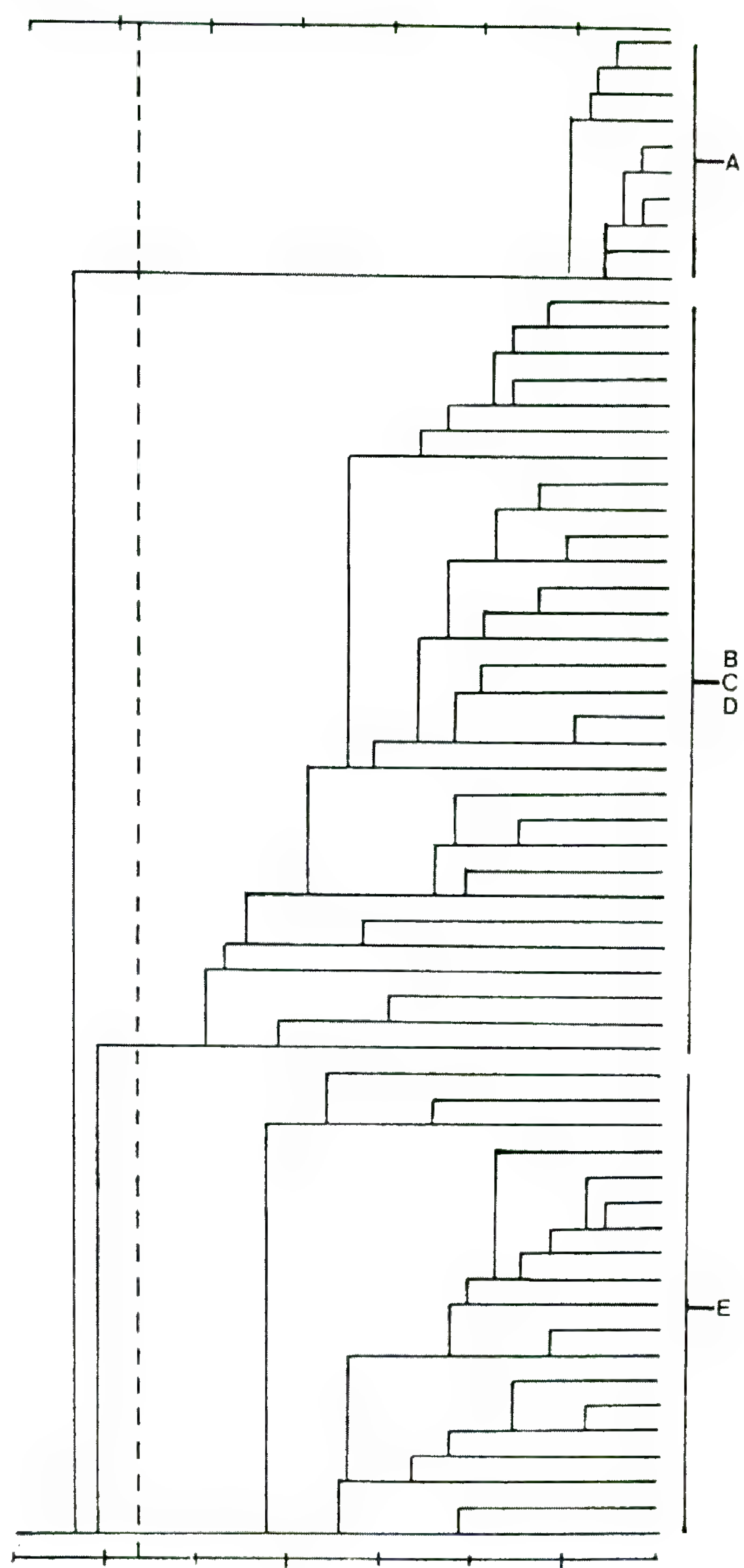


FIG. 2. Cluster analysis of all populations, showing three main groups. Phenon line is represented by the dashed line.

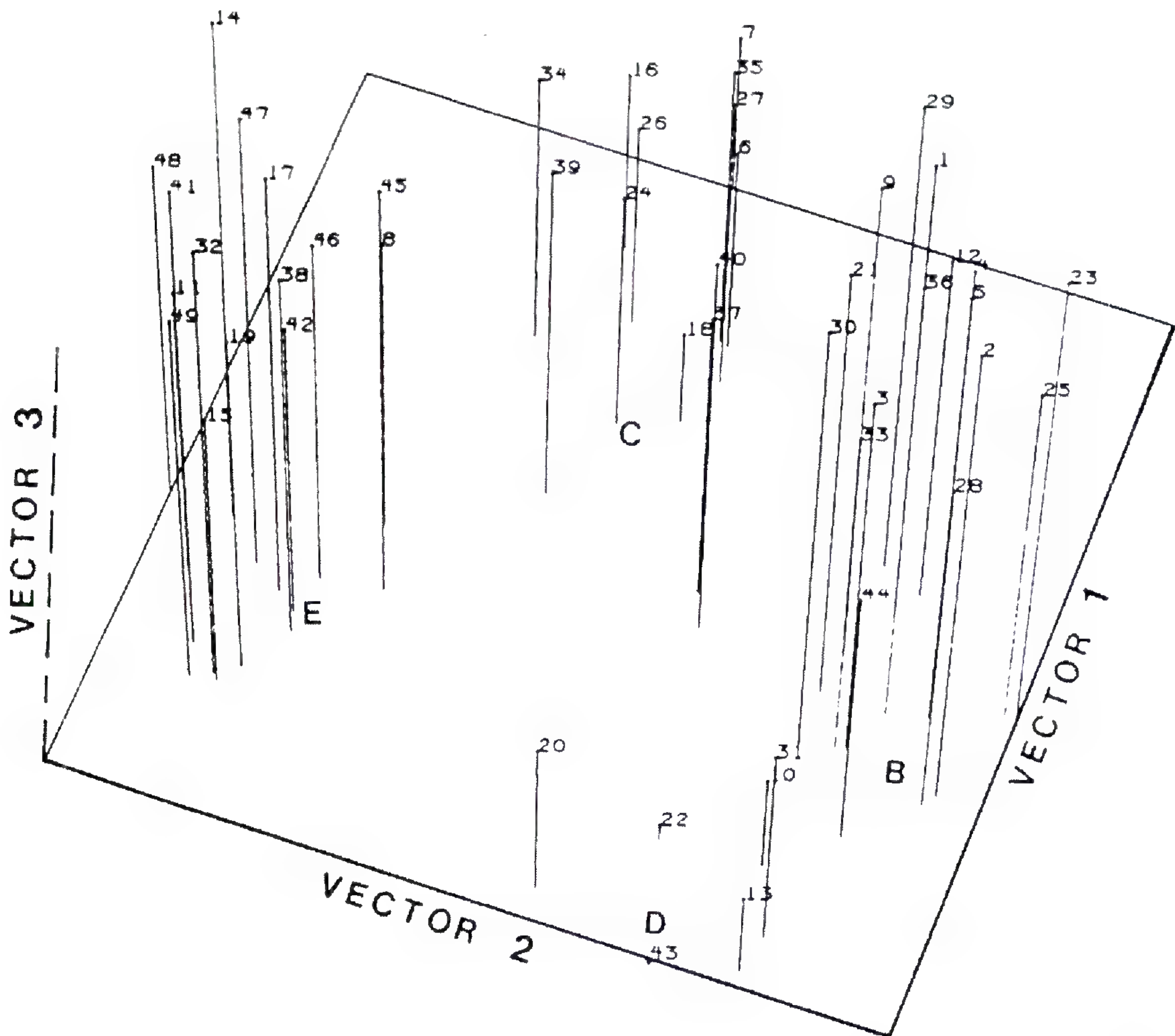


FIG. 3. Three dimensional representation of groups B, C, D, and E analyzed with MANOVA.

which represents *E. nealleyi*, is separated from the complex of groups B, C, and D. It is a fairly homogeneous group closely related to group C (*E. avenaceum*).

Electrophoretic Analysis.—Figure 4 shows the electrophoretic activity found in the different enzyme systems assayed, and the following information was gathered.

PGI (Fig. 4a): The phenotypes found in this survey showed PGI as a dimeric enzyme; with two loci that appear to be compartmentalized. *GOT* (Fig. 4a): This system, typically dimeric, appears to have two loci with each locus having two alleles. *IDH* (Fig. 4b): In this system phenotype 1 was observed exclusively in *D. pulchella*. The *E. avenaceum-pilosum* complex has high variation within this system. However, phenotype 5 appears to be exclusive to "typical" *E. pilosum* from populations in the southwestern United States and northern Mexico. Phenotypes 2 and 4 were common in *E. nealleyi*, as well as *E. avenaceum*. *Erioneuron grandiflorum* had phenotypes 4 and 6, again suggesting a heterozygous condition. *PGM* (Fig. 4c): This system appeared

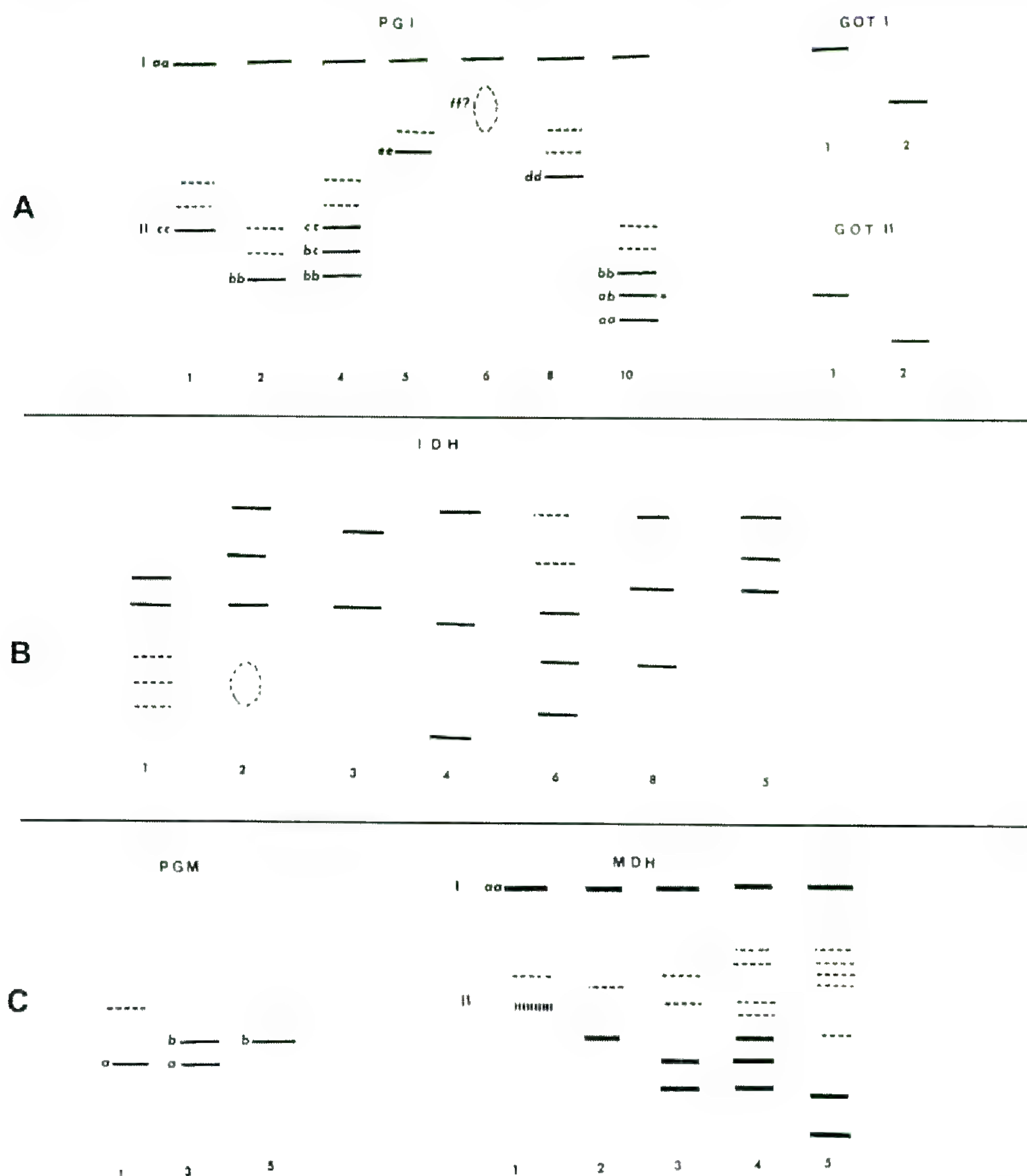


FIG. 4. 4a. Schematized electrophoretic banding patterns for PGI and GOT. The allelic designations given to the left of some bands are presumed on the basis of observed variation within that enzyme system. 4b. Diagrammatic electrophoretic banding patterns of IDH. 4c. Schematized electrophoretic banding patterns for PGM, and MDH.

to be monomeric, where the genetic interpretation seemed more obvious. Phenotype 1 again was exclusive to *D. pulchella*, phenotype 2 almost exclusive to *E. avenaceum*, and all others species presented a mixture of both. The heterozygous condition (phenotype 3) occurred only in *E. grandiflorum*. MDH (Fig. 4c): This system showed a dimeric condition with two loci. *Dasyochloa pulchella* had phenotype 1 only, whereas *E. nealleyi* appeared to have phenotype 2, *E. avenaceum* and *E. grandiflorum* had phenotype 4, and *E. pilosum* had phenotypes 2 and 4. In this system the presence of several unresolved bands suggests new phenotypes. The limited sample number within species does not allow a stronger differentiation of phenotypes.

The PCA of 208 individuals assayed shows a clear separation of the *D. pulchella* individuals as a distinct group. The *Erioneuron* species form two groups without a clear separation. Figure 5 shows the PCA for all species, the populations are represented by one individual. The first two components account for most of the variation present in the analysis (53.66 and 16.92 percent of trace, respectively). The enzyme systems PGI, GOT, IDH, and MDH contributed to explain the separations of groups. All the *D. pulchella* samples remained distinct from *Erioneuron* species. Within *Erioneuron* a cluster representing *E. nealleyi* was observed, whereas the *E. avenaceum-pilosum* complex were mixed.

The results suggest that allozyme variation is concordant with the morphological analysis for the separation of *Erioneuron* species. Electrophoretic evidence supports *Dasyochloa* as a distinct monotypic genus.

In the *Erioneuron* species, the electrophoretic evidence suggests that “typical” *E. avenaceum* and *E. pilosum* are distinct groups. *Erioneuron nealleyi* might be considered as a distinct group, although closely related to *E. avenaceum*. Cytological studies indicate that *E. avenaceum* and *E. pilosum* are diploid ($2n=16$), and *E. grandiflorum* tetraploid ($2n=32$) [Valdés-Reyna, 1985]. Hybridization in *E. grandiflorum* is suggested by the electrophoretic data which is concordant with cytological information.

CONCLUSIONS

The results of these and previous studies suggest that the genus *Erioneuron* has three species with seven varieties distributed in the United States, Mexico, Bolivia, and Argentina, and also supports the recognition of the genus *Dasyochloa*.

Morphologically the groups identified represent 1) involute leaf blades with inflorescences included in leafy fascicles (*D. pulchella*), and 2) conduplicate leaf blades with exserted inflorescences (*Erioneuron*). *Dasyochloa* has a different electrophoretic, anatomical, and morphological pattern. Within the genus *Erioneuron*, *E. nealleyi* is a relatively uniform group with deeply cleft lemmas having truncate lobes and long glumes. *Erioneuron avenaceum* and *E. pilosum* are two relatively homogeneous taxa, with *E. grandiflorum* intermediate between them. Electrophoretic analysis and chromosome number reports suggest that *E. grandiflorum* is a result of hybridization between these two species.

TAXONOMY

- 1. Inflorescences long-exserted; stolons when present not ascending to prostrate; blades conduplicate **Erioneuron**
- 1. Inflorescences included in and surpassed by fascicles of leaves at top of short naked culms; stolons slender, ascending, wiry, abundant; blades involute **Dasyochloa**

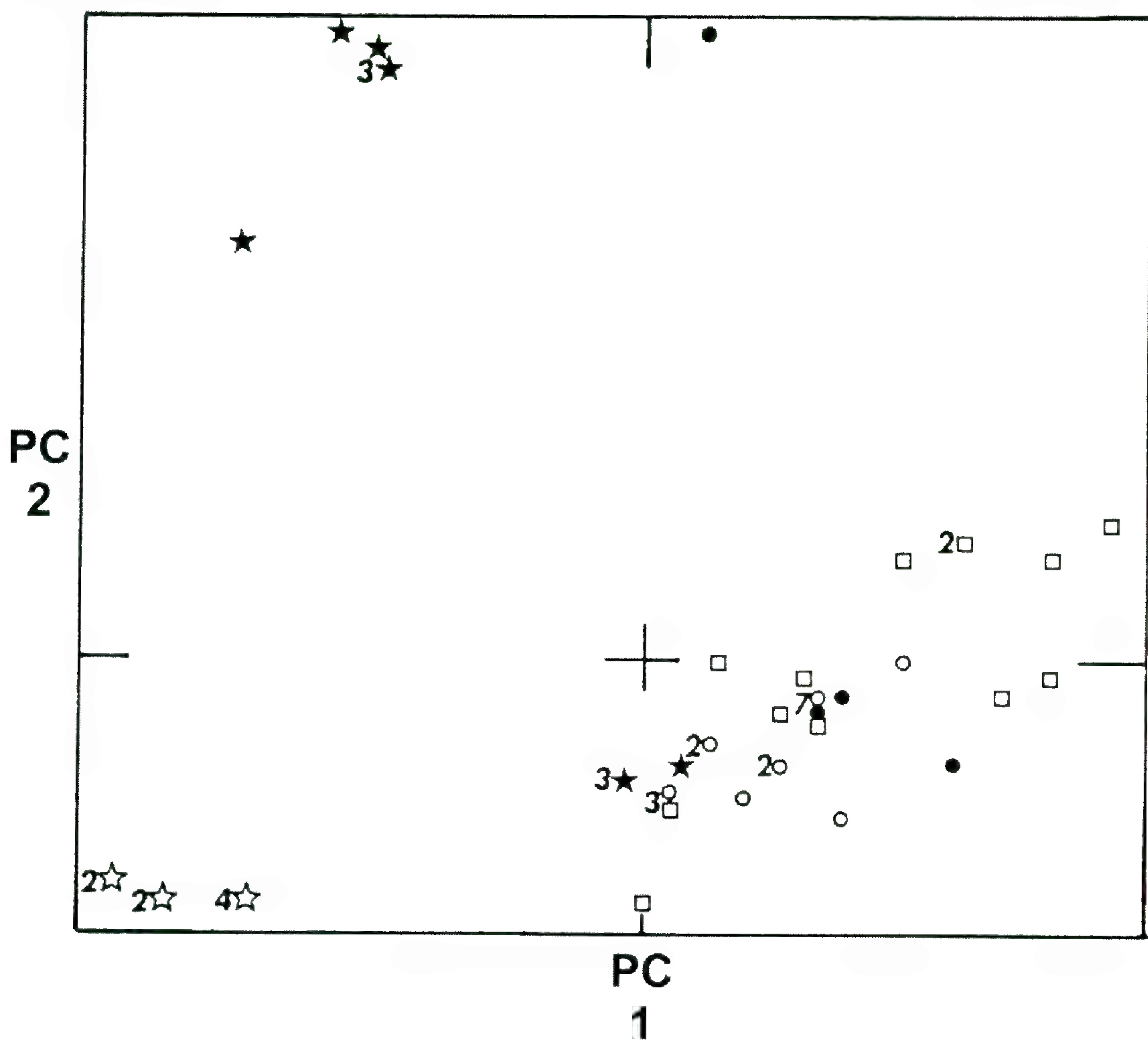


FIG. 5. Principal components analysis showing first two components for all groups. Groups are distinguished as: (group A - *Dasyochloa*), (group B - *Erioneuron pilosum*), (group C - *E. avenaceum* - *pilosum* complex), (group D *E. avenaceum* - *grandiflorum* complex), (group E = *E. avenaceum* - *nealleyi* complex).

ERIONEURON

Erioneuron Nash in Small, Fl. S.E. U.S. 143. 1903. TYPE: *Erioneuron pilosum* (Buckl.) Nash.

Tufted perennials, occasionally stoloniferous. Culms erect, leaves mostly basal. Inflorescence an open or contracted panicle or a raceme. Spikelets with several florets, the upper florets staminate or neuter, disarticulation above the glumes and between the florets. Glumes membranous, thin, subequal, acute or acuminate, 1-veined. Lemmas broad, rounded on the back, 3-veined, conspicuously long-hairy along the veins at least below, the central vein often extended into a short awn, the two lateral veins near the margins sometimes extended as small mucros; lemma apex narrowly margined, toothed, or obtusely 2-lobed. Palea slightly shorter than the lemmas, ciliate on the keels, long hairs on the basal portion between the veins. Lodicules two, adnate to base of the palea. Stamens 1–3, having the

monandrous condition common in two species. Caryopsis oblong, glossy and translucent; embryo half the caryopsis length. Seedlings with a shaggy-white-villous indument. Basic chromosome number $x=8$.

A New World genus of three species with 7 varieties including the typical; distributed in the United States, Mexico, Bolivia and Argentina.

KEY TO THE SPECIES

1. Lemmas entire or with a small notch 0.1–0.5 mm deep; lemma midvein extending into an awn 0.5–2.0(–2.5) mm long; glumes both shorter than lowermost floret 1. *E. pilosum*
1. Lemmas with a notch 1.0–2.5 mm deep; lemma midvein extending into an awn 2–4 mm long; glumes (at least the second) equal to or longer than lowermost floret 2
2. Lemma lobes obtuse to broadly acute; lemma notch 1–2 mm deep; lateral veins of lemma not extending as small mucros; plants 10–30 cm tall, stolons common 2. *E. avenaceum*
2. Lemma lobes rounded to truncate; lemma notch 1.5–2.5 mm deep; lateral veins of lemma extending as small mucros to 0.5 mm long; plants 30–65 cm tall, stolons absent 3. *E. nealleyi*

1. ***Erioneuron pilosum*** (Buckl.) Nash in Small, Fl. S.E. U.S. 144, 1327. 1903. *Uralepis pilosa* Buckl., Proc. Acad. Natl. Sci. Phila. 14:94. 1862 [Not *U. pilosa* Buckl. 95. 1862 – *Tridens muticus* (Torr.) Nash]. *Sieglingia pilosa* (Buckl.) Nash in Britton & Brown, Ill. Fl. N. U.S. 3:504. 1898. *Tricuspis pilosa* (Buckl.) A.A. Heller, Cat. N. Amer. Pl. ed 2. 28. 1900. *Triodia pilosa* (Buckl.) Merr., U.S.D.A. Circ. 32:9. 1901. *Tridens pilosus* (Buckl.) A. S. Hitchc., Contr. U.S. Natl. Herb. 17:357. 1913. TYPE: middle Texas, *Buckley s.n.*. [HOLOTYPE: P-DU? not seen; LECTOTYPE, here designated: *Wright 781* (PH!)].

Tricuspis acuminata Munro ex A. Gray, Proc. Acad. Nat. Sci. Phila. 14:335. 1863. *Triodia acuminata* (Munro) Benth. ex Vasey, Dept. Agric. Special Rep. 63:35. 1883. “nomen nudum”; Vasey, U.S.D.A. Div. Bot. Bull. 12(2):pl. 32. 1891. *Sieglingia acuminata* (Munro) Kuntze, Revis. Gen. Pl. 2:789. 1891. TYPE: western Texas, *Wright 781*. (HOLOTYPE: GH!; ISOTYPE: US!).

Caespitose perennials, occasionally stoloniferous. Culms erect, (6–)10–30(–40) cm tall, glabrous to hispidulous, usually one internode showing above the dense tuft of basal leaves, the nodes glabrous to villous. Sheaths smooth, striate, keeled, margins hyaline and often erose, tuft of hairs typically present at the throat, the hairs up to 2 mm long. Ligules 2.0–3.5 mm long, a fringe of hairs. Blades (1–)3–6(–9) cm long, (0.5–)1–1.5(–2.5) mm wide, conduplicate, keeled, rarely flat, usually basal, striate, the margins strongly cartilaginous, the apex acute, pilose near the collar, both surfaces sparsely pilose to glabrous, grayish-green. Inflorescences a compact panicle or raceme, (1–)1.5–4(–6) cm long, (0.5–)1.0–2.0(–2.5) cm wide, ovoid, exserted above the basal leaves (occasionally in overgrazed areas the inflorescences borne among the basal culms), with 3–9 short pedicellate spikelets per branch. Spikelets (6–)8–12(–15) mm long, with (5–)6–12(–20)

florets, laterally compressed, purplish when immature to pale or pale with a purplish tinge when mature, frequently light green, disarticulation above the persistent glumes. Glumes subequal, glabrous, acuminate, 1-veined, the first (2.5–)4–5(–7) mm long, the second (3–)5–6(–7) mm long, shorter than the spikelet, pale, the margins and apex membranous. Lower lemmas (3–)4–5(–6) mm long, acuminate; 3-veined, the lateral veins near the margins, green or purplish green becoming stramineous with age, densely pilose on the base of the keel and margins; the midvein extending into a short, straight awn from an entire or minutely notched apex; the notch 0.3–0.5 mm deep, awns 1–2(–3) mm long. Paleas 2–3(–4) mm long, elliptic, pilose on the back and margin below. Stamens with anthers 0.3–1 mm long. Caryopsis 1–1.5 mm long, oblong, translucent. Chromosome number $2n=16$.

Distribution.—Dry rocky hills and mesas, often in oak and pinyon-juniper woodlands. United States southern part of Nevada, Utah, Colorado, and Kansas, south through Arizona, New Mexico, Texas to northern Mexico in Chihuahua, Coahuila, Nuevo León, and Tamaulipas. Present also in Argentina where it is represented by two varieties in the semi-arid zones in the central and west regions north to La Patagonia.

KEY TO THE VARIETIES

1. Lemma awns 2–2.5 mm long; plants from Argentina *E. pilosum* var. *longearistatum*
1. Lemma awns 0.5–2 mm long; plants from the United States, Mexico or Argentina 2
2. Lemma awns to 0.5 mm long; first glumes to 2.5 mm long, second glumes to 3 mm long; plants from Provincia de Mendoza, Argentina *E. pilosum* var. *mendocinum*
2. Lemma awns 1–2 mm long; first glumes 4–5 mm long, second glumes 5–6 mm long; plants from United States and Mexico *E. pilosum* var. *pilosum*

***Erioneuron pilosum* (Buckl.) Nash var. *mendocinum* (Parodi) Nicora, Darwiniana 18:104. 1973. BASIONYM: *Tridens pilosa* (Buckl.) Hitchc. var. *mendocina* Parodi, Rev. Argent. Agron. 4:250. 1937. TYPE: ARGENTINA. Mendoza, Las Heras, Potrerillos, estancia El Salto, *Ragonese* 94 (HOLOTYPE: not seen; the holotype, since Parodi (1937) did not designate one when it was described, has not been located. This was also mentioned by Anton (1977).**

Anton (1977) followed Parodi's (1937) variety with the geographic distribution restricted to the Provincia de Mendoza. A fragment of *Kurtz* 10036 (CORD), which Anton (1977) examined, was studied. The taxon belongs to *E. pilosum* and the varietal description given by Parodi (op. cit.) is as follows.

Caespitose perennial. Culms 8–15 cm tall, usually one internode showing above the dense tuft of basal leaves, the nodes glabrous. Ligules a fringe of hairs. Blades 2–5 cm long, to 2 mm wide, conduplicate, pilose on the abaxial surface. Inflorescences a panicle 1–2 cm long, contracted, ovoid.

Glumes 1-veined, keeled, acuminate, the first 2.5 mm long, the second 3 mm long. Lemmas acuminate, without cleft, 4 mm long, with an awn to 0.5 mm long. Stamens 3, anthers 0.2–0.5 mm long.

1b. *Erioneuron pilosum* (Buckl.) Nash var. *longearistatum* (Kurtz) Anton, Kurtziana 10:51–67. 1977. BASIONYM: *Triodia avenacea* var. *longearistata* Kurtz, Rev. Mus. La Plata 5:299. 1893. TYPE: ARGENTINA. Colinas secas cerca de la Estancia La Era, al SO de San Francisco del Chanar, Kurtz 6729. (LECTOTYPE: CORD!).

Sieglingia argentina Kuntze, Revis. Gen. Pl. 3:367. 1898. *Tridens pilosa* (Buckl.) Hitchc. var. *argentina* (Kuntze) Parodi, Rev. Argent. Agron. 4:251. 1937. *Erioneuron pilosum* (Buckl.) Nash var. *argentinum* (Kuntze) Nicora, Darwiniana 18:104. 1973. TYPE: ARGENTINA. PROV. RIO NEGRO: Rio Colorado, Lorentz s.n. (HOLOTYPE: LP?; ISOTYPE: CORD).

Erioneuron pilosum (Buckl.) Nash var. *parodianum* Sanchez, Darwiniana 22:171. 1979. *Dasyochloa argentina* (Kuntze) Caro var. *parodiana* (Sanchez) Caro, Dominguezia 2:7. 1981. TYPE: ARGENTINA. DEPTO. LIHUEL CALEL: La Pampa, Lihuel Calel, Krapovickas 3633 (HOLOTYPE: BAF!; ISOTYPE: CORD).

Dasyochloa argentina (O. Kuntze) Caro var. *aristiglumis* Caro, Dominguezia 2:4. 1981. *Erioneuron pilosum* (Buckl.) Nash var. *aristiglumis* (Caro) Sanchez, Lilloa 36:135. 1983. TYPE: ARGENTINA. DEPTO. RIVADAVIA: La Rioja, entre Potrerillo y Porongo, Kurtz 2690 (HOLOTYPE: BAF!).

Caespitose perennial. Culms 15–30 cm tall, leaves basal. Blades 5–10 cm long, 2.0–2.5 mm wide, conduplicate, pilose on the abaxial surface. Inflorescences a panicle, 2–3 cm long, to 2 cm wide, short, dense, contracted spikelets 8–10 florets. Glumes acuminate, the first 4–5 mm long, the second 5–7 mm long. Lemmas to 5 mm long, with a notch to 0.5 mm deep, lemma awns (1–)2–2.5 mm long. Stamens 1–3, commonly 1–2, anthers to 1 mm long.

This is a variety that can be differentiated by the length of the awns which is 2–2.5 mm long, as reported by Parodi (1937) in the original description.

Distribution.—This is a common variety distributed in the central and western parts of Argentina. It is also frequent in the mountains in the Provincia de Cordoba (Anton 1977).

Erioneuron pilosum var. *parodianum*, an endemic variety from Sierra Lihuel-Calel de la Pampa, described by Sanchez (1979) on the basis of lateral veins of lemmas that are pilose only in the lower one third, is included here as a synonym. The character of vestiture of the lemmas was included in the phenetic analysis of this study, and significant differences were not found in the populations analyzed at the inter- and intraspecies level or at the interpopulation level. Therefore, this variety is a synonymy of *E. pilosum* var. *longearistatum*, which Sanchez (op. cit.) reported as anatomically similar to the var. *parodianum*. A similar situation exists with *Dasyochloa argentina* var. *aristiglumis* Caro (1981) which is based on the acuminate glumes pro-

jecting into an awn 0.5–1 mm long. In the numerical analysis no significant differences were found for this character. It is important to mention that during the analysis of the paratype of this variety (*Stuckert 1761*) one stoloniferous specimen was observed.

2. *Erioneuron avenaceum* (Kunth) Tateoka, Amer. J. Bot. 48:572. 1961.

Triodia avenacea Kunth, Nov. Gen. Sp. Pl. 1:156 pl. 48. 1815. *Uralepis avenacea* (Kunth) Kunth, Revis. Gramin. 1:108. 1829. *Dasychloa avenacea* (Kunth) Willd. ex Steud., Nom. Bot. ed 2. 1:484. 1840. *Tricuspis avenacea* Thurb. ex A. Gray, Proc. Acad. Nat. Sci. Philadelphia 14:335. 1863. *Sieglingia avenacea* (Kunth) Kuntze, Revis. Gen. Pl. 2:789. 1891. *Tridens avenaceus* (Kunth) Hitchc., Contr. U.S. Natl. Herb. 17:357. 1913. TYPE: MEXICO: "Crescit in convalle Mexicana inter montem Chapoltepec et Penol de los Banos, alt. 1190 hexap," *Humboldt and Bonpland s.n.* (HOLOTYPE: P not seen).

Uralepis avenacea (Kunth) Kunth var. *viridiflora* Fourn., Mexic. Pl. 2:110. 1886, "nomen nudum." TYPE: MEXICO: San Luis Potosi, *Virlet 1379*.

Triodia avenacea Kunth var. *breviaristata* Kurtz, Rev. Mus. La Plata 5:301. 1893. TYPE: MEXICO: Valle de Mexico, *Schaffner 158* (HOLOTYPE: US!).

Triodia grandiflora Vasey, Contr. U.S. Natl. Herb. 1:59. 1890. *Sieglingia avenacea* (Kunth) Kuntze var. *grandiflora* (Vasey) L. H. Dewey, Contr. U.S. Natl. Herb. 2:538. 1894. *Sieglingia grandiflora* (Vasey) Beal, Grasses N. Amer. 2:471. 1896. *Tridens grandiflorus* (Vasey) Wooton and Standl., New Mexico Agric. Exp. Sta. Press Bull. 81:129. 1912. *Erioneuron grandiflorum* (Vasey) Tateoka, Amer. J. Bot. 48:572. 1961. *Erioneuron nealleyi* (Vasey) Tateoka var. *grandiflorum* (Vasey) Beetle, Phytologia 27:442. 1974. *Erioneuron avenaceum* (Kunth) Tateoka var. *grandiflorum* (Vasey) Gould, Brittonia 26:60. 1974. TYPE: UNITED STATES. TEXAS. Presidio Co.: Chenate Mts., *Nealley 823* (ISOTYPE: US!; PARATYPE: NY!; TOPOTYPE: MO!).

Tufted perennials, stolons rare to abundant (more common on central Mexico populations). Culms (7–)10–30(–40) cm tall, (0.4–)0.7–1.0 mm diam., glabrous, leaves basal, a single elevated culm node with a reduced leaf, the nodes glabrous to villous. Sheaths smooth, striate, keeled, margins hyaline, a tuft of hairs present at the throat, the hairs up to 2 mm long. Ligules, a fringe of hairs, to 0.5 mm long. Blades folded (conduplicate), keeled, rarely flat, striate, margins cartilaginous, (1.5–)3–5(–8) cm long, (0.5–)1–1.5(–2.5) mm broad, pilose near the collar, both surfaces sparsely pilose. Inflorescences a panicle, 2–8(–10) cm long, 1–3 cm wide, compact or open, ovoid, exserted above the basal leaves, stramineous to purple, with 2–10(–16) short pedicellate spikelets per branch. Spikelets 6–8(–10) mm long, with (4–)6–12(–20) florets, laterally compressed, keeled, purplish, disarticulation above the persistent glumes. Glumes subequal, glabrous, acuminate, 1-veined, the first 4–7 mm long, the second (4–)6–9 mm long. Lemmas 4–6(–7) mm long, acuminate, 3-veined, the lateral veins near the margins, densely pilose near the base to the middle, purplish green, lemma lobes obtuse to bluntly acute, the midvein extends into an awn from a notched apex 1–2 mm deep, awns 2–4 mm long. Paleas 2.0–3.5 mm long, elliptic, pilose on the back and margins below. Stamens 1–3, anthers 0.4–

1.0 mm long or when monandrous the anther to 1.3 mm long. Caryopsis 1.0–1.4 mm long, oblong, translucent. Chromosome number $2n=16, 32$.

Distribution.—This species is a highly variable, common in rocky areas in southwestern United States, to central Mexico, also in Bolivia and Argentina. Included here as a synonym is *E. grandiflorum*, which is not significantly different based on the phenetic analysis, and the electrophoretic analysis. The electrophoretic analysis also suggests a hybrid origin. In Argentina three varieties are recognized following Anton (1977).

KEY TO THE VARIETIES

1. Lemma lobes 0.7–1 mm long; glumes shorter than the spikelet 2a. *E. avenaceum* var. *kurtzianum*
1. Lemma lobes 1.5–2 mm long; glumes as long as or longer than the spikelet (at least lowermost floret)
2. Second glumes (7–)8–11(–13) mm long; plants from northwest Argentina 2c. *E. avenaceum* var. *longiglume*
2. Second glumes 5.0–6.5 mm long; plants from southwestern United States, Mexico, or the Andean highlands of Argentina and Bolivia
3. Lower lemmas 3.5–4.5(–5) mm long; plants from the Andean highlands of Argentina and Bolivia 2b. *E. avenaceum* var. *pygmaeum*
3. Lower lemmas 5–6 mm long; plants from the southwestern United States, and Mexico *E. avenaceum* var. *avenaceum*

2a. *Erioneuron avenaceum* (Kunth) Tateoka var. *kurtzianum* (Parodi)
Anton, Kurtziana 10:62. 1977. BASIONYM: *Tridens avenacea* (Kunth) Hitchc. var. *kurtziana* Parodi, Rev. Argent. Agric. 4:256. 1937. TYPE: ARGENTINA. PROV. SAN JUAN. Depto. Zonda: Precordillera entre Barreales, Tontal y Retamito, entre Agua Pinta y Pedernal, Kurtz 9850 (HOLOTYPE: US!; ISOTYPES: CORD, BAF!).

This is a variety Parodi (1937) considered as a possible link between *E. avenaceum* and *E. pilosum*, due to the lemma cleft depth. He suggested the possibility of a hybrid origin. Anton (1977) examined this variety and agreed with the intermediate position. She justified the variety rank on the basis of the lemma lobes, as Parodi (op. cit.) did, adding inflorescence branch pubescence and inflorescence shape. It is considered an endemic variety known only from the type locality.

Anton (op. cit.) discussed the differences between typical *E. avenaceum* and the three varieties that occur in Argentina, since Parodi (op. cit.) suggested that the South American forms might be considered as different species. She concluded that the Argentine material did not possess stolons when compared with the type specimen of *E. avenaceum* from central Mexico. *Erioneuron avenaceum* var. *kurtzianum* seems most allied with typical *E. avenaceum* from North America. Both possess glumes that are shorter than the spikelet, and the palea never reaches the lemma awn base. The differences between varieties are that *E. avenaceum* var. *kurtzianum* has a lemma cleft that is more shallow, and the size of the awns is longer than typical *E. avenaceum*.

Study of the type collection leads to the same conclusion that was outlined by Parodi (op. cit.) and Anton (op. cit.). However, more representative specimens of this variety, need to be studied. In the analysis of the populations from North American *E. avenaceum* var. *avenaceum* the lemma cleft was from 0.9–2.2 mm deep, and awn length from 2–4 mm long. These are not significant differences and neither is inflorescence shape or branch vestiture.

- 2b. *Erioneuron avenaceum* (Kunth) Tateoka var. *pygmaeum* (Hackel) Anton, Kurtziana 10:63. 1977. BASIONYM: *Triodia avenacea* var. *pygmaea* Hackel, in R.E. Fries, Nov. Acta Regiae. Soc. Sci. Upsal., ser 4, 1:179. 1905. *Tridens avenacea* var. *pygmaea* (Hackel) Parodi, Rev. Argent. Agron. 4:253. 1937. TYPE: (HOLOTYPE: W?; ISOSYNTYPES: CORD!).

Variety *pygmaeum* has a distribution restricted to the Andean highlands of Argentina and Bolivia, usually above 2500 m in elevation. Parodi (1937) characterized the variety as low plants, (less than 10 cm high), with long glumes. Anton (1977) reported the similarity with the var. *longiglume*, where many intermediate specimens make it difficult to separate the two varieties. She suggested the geographical distribution as the most important point. A single collection from Bolivia, *Cardenas 204* (GH) was determined as var. *pygmaeum*. However, as Anton (op. cit.) suggested, a close relationship exists with var. *longiglume*. Therefore, the need for a definitive study on these two varieties exists.

- 2c. *Erioneuron avenaceum* (Kunth) Tateoka var. *longiglume* (Parodi) Anton, Kurtziana 10:65. 1977. BASIONYM: *Tridens avenacea* var. *longiglumis* Parodi, Rev. Argent. Agron. 4:255. 1937. *Dasyochloa longiglumis* (Parodi) Caro var. *longiglumis* Caro, Dominguezia 2:8. 1981. TYPE: ARGENTINA. PROV. CATAMARCA. Dpto. Andalgalá: Las Minas. *Jorgensen 1718* (HOLOTYPE: ?; ISOTYPES: BAF! GH! MO! US!).

Dasyochloa longiglumis (Parodi) Caro var. *cabreræ* Caro, Dominguezia 2:13. 1981. *Erioneuron avenaceum* var. *cabreræ* (Caro) Sánchez, Lilloa 36:135. 1983. TYPE: ARGENTINA. PROV. LA RIOJA. Dpto. Famatina: Quebrada de la Aguadita, *Cabrera 18096* (HOLOTYPE: BAF!).

This variety is characterized by the length of the glumes 7–12 mm long (sometimes equal), and lemma lobes that are oblique and obtuse.

Distribution.—Between the 1800–3000 m elevation, in northwest Argentina. Included here as a synonym is *Dasyochloa longiglumis* var. *cabreræ* which is distinguished by the hair at the base of the lateral veins of the lemmas. As mentioned in the phenetic analysis the vestiture character of the lemmas did not show significant difference. The results of the morphological analysis show that this variety is closely related to the *E. nealleyi* from North America based upon the glumes sizes.

3. *Erioneuron nealleyi* (Vasey) Tateoka, Amer. J. Bot. 48:572. 1961. *Triodia nealleyi* Vasey, "nomen nudum" Vasey, Bull. Torrey Bot. Club 15:49. 1888; Vasey, U.S.D.A. Div. Bot. Bull. 12:pl. 36. 1891. *Sieglingia nealleyi* (Vasey) L.H. Dewey, Contr. U.S. Natl. Herb. 2:538. 1894. *Tricuspis nealleyi* (Vasey) Heller, Cat. N. Amer. Pl. ed 2. 28. 1900. *Tridens nealleyi* (Vasey) Woot. and Standl., New Mexico Agric. Exp. Sta. Press Bull. 81:129. 1912. *Erioneuron avenaceum* (Kunth) Tateoka var. *nealleyi* (Vasey) Gould, Brittonia 26:60. 1974. TYPE: UNITED STATES. TEXAS. Presidio Co.: Cibolo Canyon, Chenate Mts, *Nealley s.n.* (ISOTYPE: US!; PARATYPE: NY!, TOPOTYPES: GH! NY! US!).

Perennials, rarely stoloniferous (only in populations from central México; San Luis Potosi). Culms (15–)35–65 cm tall, 0.8–2.0 mm diam., glabrous to hispidulous, the nodes glabrous to densely villous. Sheaths smooth, striate, keeled, margins hyaline, tuft of hairs present at the throat, the hairs up to 2(–3) mm long. Ligules a fringe of hairs, 0.2–0.6 mm long. Blades 5–10 cm long, 2.0–2.5 mm wide, folded (conduplicate), when moist conditions flat, striate, margins cartilaginous, pilose near the collar, both surfaces pilose to villous, green. Inflorescences a compact panicle 5–10 cm long, 1–3 cm wide, narrow, rarely open, ovoid to usually 2–4(–6) times as long as broad, occasionally interrupted in the lower half, light green to purple, with 5–17 short pedicellate spikelets per branch erect to appressed. Spikelets 7–11 mm long with 3–15 florets, laterally compressed, keeled, purplish to pallid. Glumes subequal, glabrous, acuminate, 1-veined, the first 5–7 mm long, the second 6–9 mm long and generally as long as or longer than lowermost floret, margins and apex membranous. Lemmas 4–6 mm long, with a notched apex 1.5–2.5 mm deep, the lobes rounded to truncate, 3-veined, the lateral veins near the margins, extending into a small mucro less than 1 mm long, scarcely to densely pilose toward the base, the midvein extending into an awn 1–3.5 mm long. Paleas 1.5–3 mm long, elliptic, pilose on the back and margins below. Stamens one (monandrous), anthers 1.0–1.5 mm long. Caryopsis 1.3–1.5 mm long, translucent. Chromosome number $2n=16$.

Distribution.—Southwestern United States to northern Mexico.

DASYOCHLOA

Dasyochloa Willdenow ex Rydberg, Fl. Colorado, Colorado Agric. Exp. Sta. Bull. 100:18,37. 1906. *Dasyochloa* Willdenow ex Steudel, Nomencl. Bot. ed. 2, 1:484. 1840. "nomen nudum." TYPE: *Dasyochloa pulchella* (Kunth) Willd. ex Rydberg.

Stoloniferous or mat-forming, perennials, with tufts at ends of ascending stolons which gradually bend down and take root "mop habit" (Arber 1934). Culms usually less than 10 cm tall. Blades involute. Inflorescences a raceme included in leafy fascicles. Lemmas notched ca half the length. As

in the genus *Erioneuron* the seedlings becomes shaggy-white-villous. This indument disappears after washing in water and is apparently composed of myriads of hair-like water-soluble crystals which are products of transpiration. This condition is previously cited by Parodi (1934) and Johnston (1943). The name is from the Greek "dasys" shaggy, hairy thick-haired, and "chloe" grass. Basic chromosome number $x=8$.

A monotypic genus distributed from central México to California, Nevada, Colorado, Arizona, New Mexico, Utah, Wyoming and Texas. The most common desert grass in the creosote-tarbush scrub.

Dasyochloa pulchella (Kunth) Willd. ex Rydberg, Fl. Colorado, Colorado Agric. Exp. Sta. Bull. 100:18,37. 1906. *Triodia pulchella* Kunth, Nov. Gen. Sp. 1:155 pl 47. 1815. *Koeleria pulchella* (Kunth) Spreng., Syst. Veg. 1:332. 1825. *Uralespis pulchella* (Kunth) Kunth, Revis. Gram. 1:108. 1829. *Dasyochloa pulchella* (Kunth) Willd. ex Steud. "nomen nudum," Nomencl. Bot. ed. 2, 1:484. 1840. *Tricuspis pulchella* (Kunth) Torr., Pacif. Railr. Rep. Parke, Bot. 4:156. 1857. *Sieglingia pulchella* (Kunth) Kuntze, Revis. Gen Pl. 2:789. 1891. *Tridens pulchellus* (Kunth) Hitchc., in Jepson Fl. Calif. 1:141. 1912. *Erioneuron pulchellum* (Kunth) Tateoka, Amer. J. Bot. 48:572. 1961. TYPE: MEXICO: "In subfrigidis, siccis, apricis regni Mexicani inter Guanaxuati, Mina de Belgrado et Cubilete," *Humboldt & Bonpland s.n.* (HOLOTYPE: P not seen; ISOTYPE: B-W no 2046, type fragment US!).

Trichodictida prolifera Cerv., Naturaleza 1:346. 1870. TYPE: near Mexico city "In collibus de Guadalupe, et de Moctezuma prope Mexicum," *Cervantes s.n.* (HOLOTYPE: ??).

Sieglingia pulchella (Kunth) Kuntze var. *parviflora* Vasey ex Beal, Grass. N. Amer. 2:468. 1896. TYPE: southern California, *Orcutt s.n.* (HOLOTYPE: US?; ISOTYPE: TAES, type fragment US!).

Low, strongly stoloniferous, tufted perennials; stolons 3–7(–11) cm long, wiry. Culms (1–)4–10(–15) cm tall, scabrous or puberulent, consisting of an elongated internode topped by a fascicle of leaves, which gradually bends down and takes root, producing other culms. Sheaths striate, margins scarious, tuft of hairs present at the throat, the hairs up to 2 mm long. Ligules a fringe of hairs 3–5 mm long. Blades (1–)2–6 cm long, strongly involute, with a pointed apex, often curved, abaxial surface scabrous, adaxial surface scaberulous. Inflorescences a panicle, or a short raceme 1.0–2.5 cm long, 1.0–1.5 cm wide, small, capitate, usually not exceeding the blades of the fascicle, light green or purple tinged, appearing white-wooly, with 2–4 short pedicellate spikelets per branch. Spikelets (5–)6–9(–10) mm long, with (4–)6–10 florets, laterally compressed, disarticulation above the persistent glumes. Glumes subequal, glabrous, acuminate, 1-veined, awn tipped, the first 6.0–8.5 mm long, the second 6.5–9.0 mm long, and as long as or longer than the florets, pale, margins membranous. Lemmas 4.0–5.5 mm long, conspicuously pilose toward the base, 3-veined, deeply cleft, cleft (1–)3.0–3.2 mm deep, the midvein extending into a straight

awn from between clearly obtuse lemma lobes, awns (1.5–)2.5–4 mm long. Paleas (2–)2.5–3.5 mm long, long pilose below, ciliate above the keels. Stamens 3, anthers 0.2–0.4 mm long. Caryopsis 1.0–1.5 mm long, translucent. Chromosome number $2n=16$.

Distribution.—Rocky soils in desert regions from southern California east to southern Colorado and south to central México. In México reported from Aguascalientes, Baja California Norte, Chihuahua, Coahuila, Durango, Guanajuato, Hidalgo, Jalisco, Querétaro, México, Nuevo León, San Luis Potosí, Sonora, Tamaulipas, and Zacatecas.

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GEOGRAPHIC SPATIAL AUTOCORRELATION OF MORPHOLOGICAL CHARACTERS IN *HEMEROCALLIS HAKUUNENSIS* (LILIACEAE)

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ABSTRACT

Spatial autocorrelation analysis of 12 quantitative characters among 30 populations of *Hemerocallis bakuunensis* was conducted to understand better their geographic variation patterns. There are two types of relationships between the mean values of the characters measured and their spatial autocorrelations: (1) significant heterogeneity of means with significant autocorrelation (mostly floral characters); and (2) significant heterogeneity of means with no significant autocorrelation (mostly vegetative characters). Perianth size shows significant north-south clinal variation and width of inner and outer perianth show a typical monotonic decline from significant positive autocorrelation at interpopulation distance of 67 to 107 km to significant negative autocorrelation at distances of 221 to 357 km. The results might result from the combinations of gene flow, genetic drift, and/or selective forces operated in populations of *H. bakuunensis*.

RESUMEN

Se realizó un análisis de correlación espacial de 12 caracteres cuantitativos en 30 poblaciones de *Hemerocallis bakuunensis* para comprender mejor sus patrones de variación geográfica. Hay dos tipos de relaciones entre los valores medios de los caracteres medidos y sus autocorrelaciones espaciales: (1) heterogeneidad significativa de las medias con autocorrelación significativa (la mayoría en caracteres florales); y (2) heterogeneidad significativa de las medias sin autocorrelación significativa (la mayoría en caracteres vegetativos). El tamaño del perianto muestra una variación clinal norte-sur significativa y la anchura del perianto interno y externo muestra una disminución monotónica típica desde una autocorrelación positiva significativa en distancias interpoblacionales de 67 a 107 km hasta una autocorrelación negativa significativa en distancias de 221 a 357 km. Los resultados podrían derivarse de las combinaciones de flujo genético, deriva genética y/o fuerzas selectivas que operan en las poblaciones de *H. bakuunensis*.

INTRODUCTION

In Korea, five species of *Hemerocallis* are recognized on the basis of morphological analysis (12 quantitative and seven qualitative characters), fieldwork, and examination of Japanese herbarium specimens (Chung & Kang 1994; Kang & Chung 1997a). These are *H. bakuunensis* Nakai, *H. thunbergii* Baker, *H. middendorffii* Tr. et Mey., *H. bongdoensis* M. Chung & S. Kang, and *H. taeanensis* S. Kang & M. Chung.

Hemerocallis bakuunensis is Korean endemic species that commonly grows at the margins of pine-oak forests, grasslands, and disturbed habitats such as chest-nut orchards in southern, central, and northwestern Korea (Chung & Kang 1994). Among the four Korean *Hemerocallis* species, populations of *H. bakuunensis* are the most variable in their inflorescence and floral morphology (Kang & Chung 1994). In addition, Chung and Kang (1994) noted that populations of *H. bakuunensis* with larger flowers are generally located in the central Korean Peninsula, while populations with smaller flowers occur in southern Korea. These patterns of geographic variation in morphological characters of the species require further study for a better understanding the species. A detailed study of the patterns of geographic variation of quantitative morphology in *H. bakuunensis* is reported here.

The principal method of analysis for this purpose is spatial autocorrelation analysis. Spatial autocorrelation statistics are summary measures of the dependence of the value of a particular variable at one location on the value of that same variable at other nearby locations. The most commonly used measure is Moran's (1950) autocorrelation coefficient I , in which geographic neighbors are compared in terms of their deviation from the mean of all observations. The method has been applied in a variety of fields including biogeography, political science, ecology, archaeology, and econometrics (Cliff & Ord 1981; Griffith 1988). Recently, this method of character analysis has been employed in the analysis of morphological characters and the spatial dispersal patterns of genetic variations because it can provide a detailed picture of geographic variation in characters (Sokal & Oden 1978a,b; Sokal et al. 1986; Jensen 1986; Chung 1995, 1996). Sokal and Oden (1978a) described five correlogram patterns of geographic variation of characters. Cline is a gradual change from the highest positive I to the lowest negative I , across all distance groups. Depression is nothing but a circular cline, with the lowest negative I between the shortest and longest distances, not the longest distance. Double depression is on the whole quite similar to that of the depression, with low I in a certain distance from which another low I was separated. Intrusion pattern shows positive I s at a certain distance, because of the homogeneity within the distance, with a sharply de-

creasing *I* bordering the distance. Crazy quilt pattern shows high *I*s surrounded by low *I*s, *vice versa*, which yields no significant *I*s at all.

The purpose of this study is to determine whether or not the 12 quantitative characters recorded for *H. hakuunensis* by Chung and Kang (1994) and Kang and Chung (1994) show any geographic patterns such as clines, depression, double depression, intrusions, and crazy quilt patterns (Sokal & Oden 1978a).

MATERIALS AND METHODS

Thirty populations representing the geographic range of *H. hakuunensis* were used for this study (Fig. 1). Measurements of 12 quantitative characters (Table 1; also see Table 2 in Chung & Kang 1994) were taken on each of 10 randomly selected individuals directly from their natural habitats from 1991 to 1995. Voucher specimens of all collections are deposited at the herbarium of Gyeongsang National University (GNUC).

For spatial autocorrelation analysis, mean values were assigned to each population for the 12 characters. Every possible pair of populations was considered as a join or a connection and was assigned to one of six distance classes based on the geographic distance between them. These six distance classes were constructed by equalizing sample sizes among the classes. The distance classes are 0<76, 76<102, 102<136, 136<169, 169<221, and 221<357 km. Moran's *I* values were calculated for interpopulational distance classes by

$$I = N \sum_i \sum_j (W_{ij} \sum_i Z_i Z_j) (\sum_i \sum_j W_{ij} \sum_i Z_i^2)^{-1}$$

(Sokal & Oden 1978a). *N* is the number of populations, W_{ij} is the join on weighting matrix, where W_{ij} is set as one if *i*th and *j*th population are in the distance class and zero otherwise, $Z_i = X_i - \bar{X}$, $Z_j = X_j - \bar{X}$, the variables X_i and X_j are the mean scores for *i*th and *j*th population, respectively, and $\bar{X}$ is the mean score for all populations. The value of *I* ranges between +1 (complete positive autocorrelation, i.e., paired populations have identical values for all characters) and -1 (complete negative autocorrelation). Each *I* value was used to test significant deviations from the expected values, $E(I) = -1/(N-1)$ (Cliff & Ord 1981). The neighboring populations in the distance class considered, with a significant positive value of Moran's *I* have similar scores, whereas those with a significant negative value should have different scores. Overall significance of individual correlograms was tested using Bonferroni's criteria (Sakai & Oden 1983). All calculations and statistical analyses were performed using the SAAP program (ver. 4.3) written by D. Wartenberg.

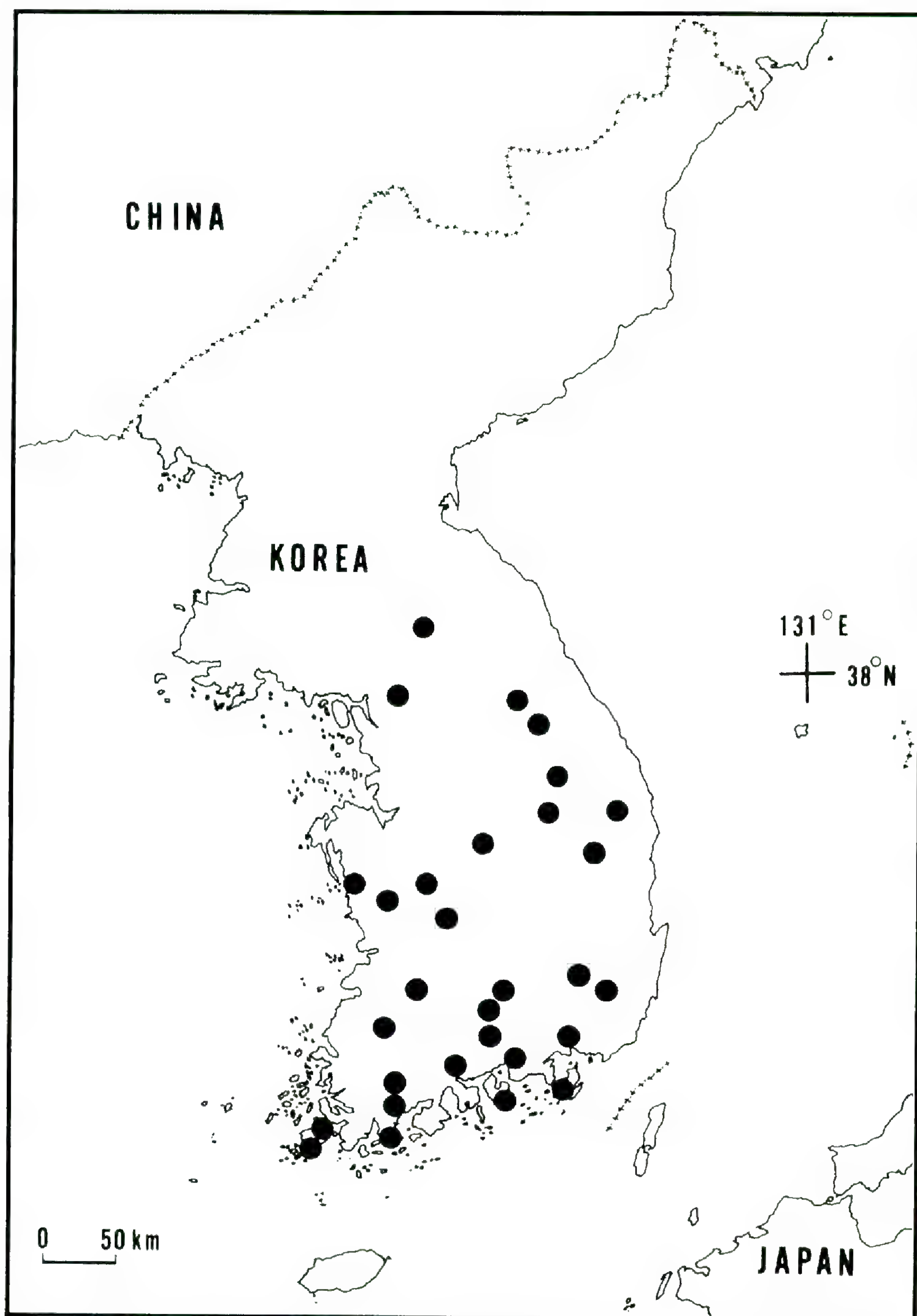


FIG. 1. The location of 30 examined populations of *Hemerocallis bakuunensis*.

TABLE 1. List of 12 quantitative characters used in the spatial autocorrelation analysis.

Acronym	Character derivation	Unit or category
PSH	Plant (scape) height	m
LIF	Length of inflorescence minus flowers	cm
NBS	Number of bracts/scape	#
NFS	Number of flowers/scape	#
LLB	Length of the lowest bracts	cm
WLB	Width of the lowest bracts	cm
LPO	Length of the perianth tube enclosing an ovary	cm
LIP	Length of the inner perianth	cm
WIP	Width of the inner perianth	cm
LOP	Length of the outer perianth	cm
WOP	Width of the outer perianth	cm
WWL	Width of the widest leaves	cm

RESULTS

Correlograms for each character are presented in Figures 2–3. Moran’s *I* was significant in 26 of 72 cases (36%). The overall correlogram for width of the lowest bracts (WLB), length of the inner perianth (LIP), width of inner perianth (WIP), length of outer perianth (LOP), width of the outer perianth (WOP), and width of the widest leaves (WWL) was significant ($P < 0.01$). As presented in Figures 2–3, plant (scape) height (PSH), length of inflorescence minus flowers (LIF), and length of the perianth tube enclosing an ovary (LPO) show depression correlograms (Sokal & Oden 1978b). On the other hand, number of bracts per scape (NBS), number of flower per scape (NFS), WIP, and WOP represent clinal variation with two, WIP and WOP, significantly autocorrelated (Figs. 2–3). In addition, it is apparent that each floral size character shows a similar pattern of geographic variation. For example, LIP and LOP, WLP and WOP (Fig. 3) revealed significant positive autocorrelation (localities connected for that distance class had similar values) for distance classes 1 to 3, followed by a steady decline until significant negative autocorrelation (localities for that distance class have dissimilar values) are recorded for distance class 5. Although LIP and LOP show increase in autocorrelation between distance classes 5 and 6, significant negative autocorrelations are also observed on these distance classes (Fig. 3). As seen in Figures 2–3, length of the lowest bract (LLB) has a crazy quilt correlogram pattern with no significant autocorrelations, whereas width of the lowest bracts (WLB) and WWL display intrusion patterns.

DISCUSSION

There were two types of relationships between means and spatial autocorrelations observed. The first pattern of significant heterogeneity of means with significant autocorrelation was observed for WLB, LIP, WIP,

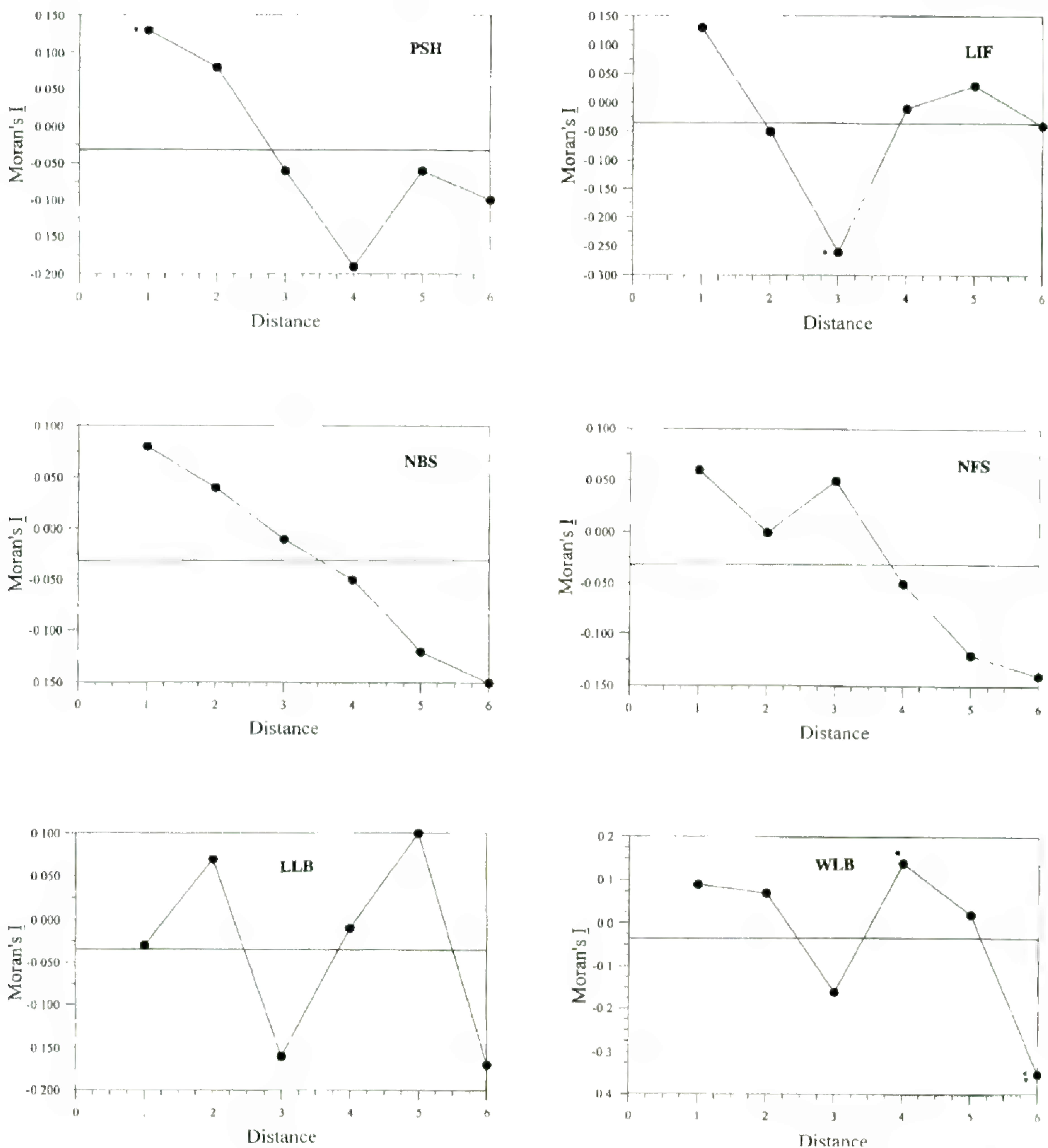


FIG. 2. Correlograms for PSH, LIF, NBS, NFS, LLB, and WLB. Significant autocorrelation coefficients ($P < 0.05$) are indicated by asterisks.

LOP, WOP, and WWL. The second pattern of significant heterogeneity of means with no significant autocorrelation is found for the other six characters. Sokal and Oden (1978b) suggested biological explanations for each of the two types of patterns. The first could result from migration, founder effects, and selective agents. The second type of relationship between means and autocorrelations could result from drift, weak migration and selection, frequent local extinctions followed by the establishment of new patches by founders, or from selection in isolated, patchy environments. Except for LLB, all characters show short distance positive autocorrelations, indicating that migration could be operating over the distances. Certainly in some

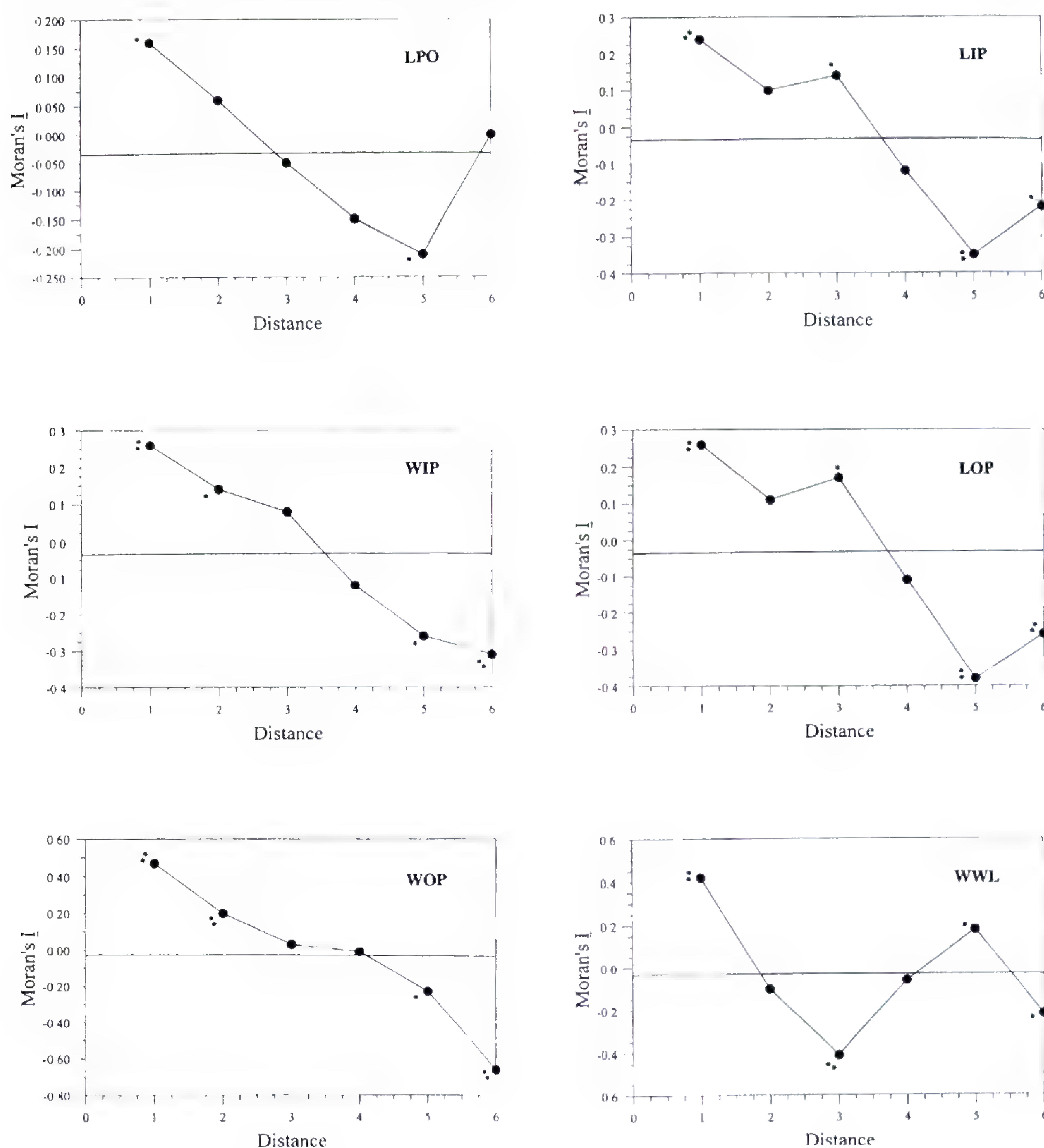


FIG. 3. Correlograms for LPO, LIP, WIP, LOP, WOP, and WWL. Significant autocorrelation coefficients ($P < 0.05$) are indicated by asterisks.

of the populations examined there are small patches whose diameter is less than interpopulational distances. The width of the lowest bracts and the longest leaves yielded a relatively long distance positive autocorrelation, which indicates these characters occur with circular or symmetrical gradients. It is of interest to note that the width of inner (WIP) and outer (WOP) perianth show a typical monotonic decline from significant positive autocorrelation at 67 to 102 Km to a significant negative autocorrelogram from 221 to 357 Km. Monotonicity is expected when separation by distance and gene flow between neighbor populations is the main factor.

The results of this study support the suggestions by Chung and Kang (1994) that there is a gradual transition of the floral morphology of *H. bakuunensis* from larger flowers in the central Korean Peninsula to smaller flowers in the southern Korean Peninsula. A similar pattern of geoclineal variation of floral morphology is previously reported in *H. dumortieri* complex in Japan (Noguchi 1986), who noted that the flower tube enclosing the ovary and the length of the internal as well as external perianths exhibited a geoclineal variation. For example, northern populations possessed much shorter, somewhat thicker flower tubes and smaller perianths in comparison with those from southern populations.

In general, vegetative characters have much showed phenoplasticity than do reproductive characters in response to environmental and developmental factors (Stebbins 1950). It might be more reasonable to discuss the biological meanings of the results using reproductive characters. According to the criteria of Sokal and Oden (1978b), patterns such as those seen in several reproductive characters of *H. bakuunensis* might result from the combinations of gene flow via pollen and seed dispersal, founder effects, genetic drift, selective forces in patchy, isolated environments. More recently, we have analyzed the spatial distribution of genotypes using spatial autocorrelation of 28 alleles in populations (20×20 -m) of *H. bakuunensis*. A genetic similarity was shared among individuals within 4.5 m distance, whereas an overall genetic dissimilarity among individuals beyond the distance, indicating that individuals in populations of *H. bakuunensis* occur on a gradient (Chung unpubl. data). Based on allozyme data obtained from 19 populations of *H. bakuunensis*, Kang and Chung (1997b) further suggested that gene movement and genetic drift may be primary factors for shaping population genetic structure among populations of *H. bakuunensis*.

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BOOK NOTICES

DUNMIRE, WILLIAM W. and GAIL D. TIERNEY. 1997. **Wild Plants and Native Peoples of the Four Corners.** (ISBN 0-89013-319-0, pbk). Museum of New Mexico Press, P.O. Box 2087, Santa Fe, New Mexico 87504. \$22.50. 312 pp.

This handsome book is both a traveler's companion and ready reference work. The authors have thoughtfully compiled and beautifully presented a wealth of information on the cultural and natural heritage of the Four Corners region of the American Southwest. The first half of the book examines the land, prehistoric and extant cultures, and plant uses by native peoples living in southwestern Colorado, northwestern New Mexico, southeastern Utah, and northeastern Arizona. The second half of this book is devoted to individually illustrated (with excellent color photographs) ethnobotanical descriptions of fifty taxa organized according to lifeform—trees, shrubs, grasses and herbs. An annotated table of 515 useful plant taxa appears after the species' ethnobotanical descriptions. This table provides a marvelous synthesis of culture-specific plant uses summarizing information from a long list of historic and recent literature. The bibliography is extensive and the index detailed. If you plan to travel in the Southwest or live there and plan to explore the region's natural and cultural riches, buy this book to help you do it.—*Bruce Benz.*

BOARD ON SCIENCE AND TECHNOLOGY FOR INTERNATIONAL DEVELOPMENT, NATIONAL RESEARCH COUNCIL. 1996. **Lost Crops of Africa. Vol. 1. Grains.** (0-309-04990-3, pbk). National Academy Press, Washington, D.C. \$24.95. 383 pp.

USAID has done yet another service by sponsoring BOSTID's compilation of information on useful African biodiversity. This volume provides an extremely useful treatment of six important African grains—African Rice, Finger Millet, Fonio, Pearl Millet, Sorghum and Tef, six short treatments discussing very locally distributed cultivated species and numerous other wild grains gathered by Africans for food. Taxonomic and evolutionary relationships of cultivated grains and wild relatives is provided and comparative nutritional value of each grain is compared to maize, the grain that has come to dominate a majority of cultivated acreage in Africa. If you teach a course in Economic Botany and don't mention these grains, do yourself and your students a favor by incorporating the information provided in this book.—*Bruce Benz.*

NEW SPECIES OF RHAMNACEAE FROM YUNNAN, CHINA

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ABSTRACT

Two new species of Rhamnaceae—*Sageretia gongshanensis* G.S. Fan and L.L. Deng from Gaoligongshan Mountain, Yunnan, China and *Rhamnus daliensis* G.S. Fan & L.L. Deng from Dali City, Yunnan, China are described and illustrated.

RESUMEN

Se describen e ilustran dos especies nuevas de Rhamnaceae—*Sageretia gongshanensis* G.S. Fan and L.L. Deng de la Montaña Gaoligongshan, Yunnan, China y *Rhamnus daliensis* G.S. Fan & L.L. Deng de Dali, Yunnan, China.

KEY WORDS: *Rhamnus*, *Sageretia*, Rhamnaceae, Yunnan, China, new species

***Sageretia gongshanensis* G.S. Fan & L.L. Deng, sp. nov. (Fig. 1).** TYPE: CHINA. YUNNAN: Gaoligongshan Mountain, 17 Apr 1979, *He Zhi-Ming* 79-0185 (HOLOTYPE: KUN); PARATYPE: CHINA. Yunnan: Baoshan Xian (County), 6 Oct 1988, *Investigative team* 7625 (SWFC).

Species haec *S. laxifloram* Hand.-Mazz. Valde similis praesertim habitu, a qua differt foliis tenuis chartaceis vel submembranaceis, venis lateratibus non impressis supra, elevatis infra, venis principalis infra tomentosis fulvidis vel brunneolis.

Woody vines, 8 m long; young shoots with gray-brown tomentum, old shoot glabrous. Leaves thin papery or submembranous, subopposite or alternate, ovate to elliptical, 4–9 cm $\times$ 2.5–5.0 cm, adaxial side densely tomentose when young, glabrescent and dull in old age except for yellow-brown tomentum near veins, the apex acuminate, the base rounded to subcordate, veins 5–7 pairs, not impressed abaxially, margins serrulate; petioles 5–9 mm long, dense brown tomentose. Flowers unknown. Inflorescence axillary, spicate, densely brown tomentose, 7–10 cm long. Fruit a drupe, obovate, seeds 2–3.

This new species is similar to *Sageretia laxiflorum* Hand.-Mazz., and is easily recognized by its thin papery or submembranous leaves, lateral veins not impressed above and raised beneath, the midrib and lateral veins yellow-brown tomentose beneath.



FIG. 1 *Sageretia gongsbanensis* G.S. Fan & L.L. Deng sp. nov. 1. Shoot with leaf, 2. Inflorescence with fruits, 3. Fruit, 4. Seeds, 5. Amplified lower surface of leaf. Drawn by H.P. Wang.



FIG. 2 *Rhamnus daliensis* G.S. Fan & L.L. Deng sp. nov. 1. Shoot with fruits and leave, 2. Fruit, 3. Amplified lower surface of leaf. Drawn by H.P. Wang.

Rhamnus daliensis G.S. Fan & L.L. Deng, sp. nov. (Fig. 2). TYPE: CHINA.

YUNNAN: Dali City, in evergreen needle-leaf forest, 2000 m alt., 21 Jul 1956, *Hsu Yung-chun* A586 (HOLOTYPE: SWFC).

A *Rhamnus globosus* affinis, sed differt foliis majoribus (4–9 cm $\times$ 2–2.5 cm), ellipticis vel oblongis, raro obovatis, non rotundatis, venis lateralibus 5–7-jugatis.

Shrubs; young shoots grey-brown, opposite or subopposite; young shoots pubescent. Leaves papery, opposite or subopposite, rare alternate, elliptic to oblong, rarely obovate, not rounded, 4–9 cm long, 2–3.5 cm broad, apex obtuse to acute, widely cuneate or slightly rounded, the base slightly oblique, margins finely serrulate, the midrib pubescent or glabrous and light yellow above when dry, densely pubescent and yellow beneath when dry; lateral veins 5–7 pairs, slightly impressed above, raised beneath; stipe 4–8 mm long, densely pubescent; stipules lanceolate, persistent, densely pubescent. Flowers unisexual, clustered in leaf axils. Fruit subglobose, black, about 4 mm diam., persistent calyx at base, stem of fruit 5–8 mm long, glabrous to rarely short pubescent, seeds 2.

This new species has a close affinity to *Rhamnus globosus* Bung., but it is easily recognized by its elliptic to oblong, rarely obovate, non rounded, 4–9 cm long, 2–2.5 cm leaves, and lateral veins of 5–7 pairs.

ACKNOWLEDGMENTS

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LEAF-PRINT ANALYSES: AN ECOLOGICALLY FRIENDLY METHODOLOGY FOR PLANT IDENTIFICATION

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ABSTRACT

Because the taxonomy of *Stanhopea* (Orchidaceae) has been established exclusively on analyses of the flower, field identification is complicated by the fugacious habit. As an aid to species confirmation, a system is offered that is ecologically friendly, economical, and statistically based. Clinical use of this system suggests it may also have value in determining the degree to which natural and man-made hybrids are related to each species-parent.

RESUMEN

Debido a que la taxonomía de *Stanhopea* (Orchidaceae) ha sido establecida exclusivamente en base al análisis de la flor, la identificación en el campo es complicada debido a su fugacidad. Como ayuda para la identificación de esta especie, se ofrece un sistema que es respetuoso ecológicamente, económico, y con base estadística. El uso clínico de este sistema sugiere que posiblemente tenga valor en la determinación del grado en el que los híbridos naturales y los obtenidos por el hombre están relacionados con cada parental.

INTRODUCTION

The genus *Stanhopea* was named in honor of Sir Philip Henry, the 4th Earl of Stanhope (1791–1855), president of the London Medico-Botanical Society from 1829–1837. Estimates of its size are numerous with old published estimates often repeated without reference to recent sources: Hawkes (1965: 8–25 or more); Hamer (1974: ca. 20); Arditti (1992: approximately 50); Dressler (1993: 55); and Bechtel et al. (1992: ca. 25). Jenny (1993) offers “about 52 species, two varieties (subspecies) and six natural hybrids.” A search of the literature coupled with clinical research suggests that combining the Dressler and Jenny estimates offers the most accurate estimate for the size of *Stanhopea*.

The genus is known from Mexico, throughout Central America, eastward across northern South America, and south-southwest into Bolivia, Ecuador, and Peru. Its northernmost invasion is reported by Kennedy (1974) from western Mexico, at a latitude farther north than San Antonio, Texas

while its southernmost reach is from the area of São Paulo, Brazil (Pabst & Dungs 1977).

Floral keys have been offered for regional areas, with most concentrating on Mexico. A key by Williams (1951) was followed by publications by Ames and Correll (1952, 1953), and a key to the Mexican members by Dodson (1963). Kennedy (1975), working with Dodson's more recent taxonomy (1975), published a hierarchy of the genus *Stanhopea* in Mexico, and more recently Williams and Whitten (1988) offer a key to the *Stanhopea* species of Panama. However, a comprehensive well illustrated treatment of the genus has yet to be offered and, in fact, the genus has comparatively ignored because its flowers are generally not long lasting. Curtis (1910) cites *Stanhopea* flowers as large and very attractive, but notes that "they are short-lived and cannot be used in floral decorations, hence cannot be considered first class." Stanhopeas have thus been relegated to the domain of orchid aficionados with the desire and space to maintain them, and as an occasional study topic by orchid botanists.

Species identification is necessary for government support of conservation. Lawmakers bluntly want to know the specific identity of the organism targeted for government conservation support. In addition, compared with other national priorities, funds for conservation are in short supply in the United States and are even less available in most of the countries situated in tropical areas where much of the world's orchid flora is abundant. Thus, working against their preservation are explicit and implicit costs attendant to identifying orchids in their habitats.

New problems arise as field collections are to be made of material to be used in the identification process. Governments often take a dim view of removing plants or plant parts, and—obviously—any plant that's collected, pressed and dried will never again set seed in its natural habitat. "The removal of even a "window" of lamina, as outlined by Cutler (1978) and utilized by Stern and Morris (1992) damages the plant (albeit minutely), opens the door to local political restrictions regarding the removal of plant material from the habitat, and requires detailed laboratory dissection and staining procedures. In general, as procedures become more complex, equipment costs increase and the likelihood of artifact introduction likewise increases. Adding to the problem is that some of these orchids flower for only very short periods during the year. *Stanhopea* flowers last only a few days so one needs to be at exactly the right place at the right time or to be able to identify members of this genus when they're not in flower. However, most orchid taxonomy is based on analyses of the flower. Indeed, Curry et al. (1988) state "the taxonomy of *Stanhopea* species rests *exclusively* (italics ours) on the morphology of the flower, changes which have apparently been influenced by the pollinators."

Thus, although problems remain with trying to correctly identify plants, this approach attempts to be bounded by parameters which clearly meet local economic, political, and botanical benchmarks. Strict requirements have been self-imposed for this study, and the identification system must meet all of the following tests:

1. It must require minimal material in the field and only that equipment in-house or easily obtainable by the laboratory of a foreign university.
2. The field work and laboratory work should be able to be carried out by any properly trained secondary science student or university undergraduate student of average ability.
3. The identification protocol should be "ecologically friendly," that is, it should not damage the plant being tested, nor should it require any part of the plant to be removed from its habitat. Briefly, it should be possible to obtain a print-sample from the plant, tag both the print-sample and the plant for field identification purposes; carrying out the identification protocol with minimal disturbance of the plant in its habitat.
4. The system must be simple and the methodology inherently economical. An identification protocol requiring extensive, expensive, detailed procedures, material, and equipment is patently undesirable in countries where economic pressures are particularly acute and government, private agencies, and individuals are all hard-pressed to fund conservation-oriented work.
5. Identification confirmations must be objective, not subjective. Identification predictions should be supported by statistical methodology not only by the personal opinion of individual A or B.
6. Lastly, and probably the greatest "acid test" is that the system must reasonably work in the "real-world" and constructively contribute to the body of botanical knowledge. What is sought is not merely a simplistic method of helping provide correct plant identifications, but one that contributes to a greater understanding of species and genera, and assists in their conservation and a more enlightened awareness and appreciation of their economic and ecological value by the general populace.

The genus *Stanhopea* was selected for several reasons. In nature, members flower only for a few days, resulting in field identifications being a matter of seeing the plant at the right time, and—as one of the genera suggested by Dr. Carl Withner—it appeared that a sufficient number of study specimens could be secured on a limited budget. The genus offers a particularly interesting challenge because, despite being represented throughout the tropics of the New World, it will not normally be encountered when in flower, thus presenting a practical group for the investigation of an identification confirmation system using means other than floral analyses.

The use of fingerprinting by law enforcement agencies depends, in part, on having a sufficiently extensive file of known prints against which an "unknown" may be checked against the three general groups of arches, loops, and whorls (U.S. Dept. Justice 1984). Among other advantages, this system is non-invasive; doing no damage to the individual being printed. Although the print match may be attempted by mating prints from an object directly with those of an individual, the system can be effective by comparing prints from an object with those from an extensive file of known

subjects. With this background from law enforcement work, particular note was taken of "leaf fingerprinting" used by students at the Universidad Autónoma de Nuevo León, the specific methodology of which was said by the professor to be unpublished work by him. However, just prior to returning the galley proofs of this manuscript, a publication by Petroski referencing one by E.M. Stoddard, was received from Dr. John Beckner of the Marie Selby Orchid Identification Center at Sarasota, Florida. Petroski (1965), outlines a similar method of leafprinting of orchid leaves using cellulose acetate (clear fingernail polish), with the resulting dried cellulose acetate film removed by forceps and dry-mounted on a microscope slide. This work's basic fingerprinting technique does not greatly differ from that of Petroski (1965) and Stoddard (1965), although the statistical analyses of the cell measurements developed by one of our number (Ferry) offers a new approach, objective in nature, to the identification of species. In addition, Stoddard's work with alfalfa, chrysanthemums, and marigolds infers the usefulness of this system to other plant families.

METHODS AND MATERIALS

Clean white styrofoam "popcorn" is dissolved in xylol until the liquid is about the consistency of warm syrup. This is applied to a clean leaf surface over an area of $\pm 2 \times 5$ cm, drying in two or three minutes. A short strip of clear transparent tape is pressed evenly and firmly over the film, but not with enough pressure to damage the leaf. The tape is peeled from the leaf, gently pressed onto a glass slide, and examined with a compound microscope. If it is desired to retain the slide permanently, a thin glass coverslip may be applied with its longitudinal edges taped to ensure holding the leaf print flat.

The slide should be marked as to which leaf surface, adaxial or abaxial, was printed. Using a felt writer or other marking pen, a small "H" or an "E" (haz: Spanish for adaxial, or envéz for the abaxial or underside of the leaf) is normally marked. The letter is followed by six digits to indicate the date, always as day-month-year (e.g. H020496/7 = Haz; 02 April, 1996/ the seventh specimen done on that date). This writing is small and done where it can be removed when the slide's permanent label is placed. In the field, the slide is now placed in a slide box or small envelope, and a small plant tag gently tied to the plant with the same set of numbers (H&E020496/7) penciled on both sides or imprinted with a stylus. It is imperative that the location be clearly stated on either the envelope or a card within the envelope for relocating the plant at a later date!

In the laboratory, the slide is photographed at 80X magnification. The microscope used in this research is a Microscoptics compound microscope with a trinocular head on which is mounted a Nikon HFM photo system.

An indexing lens inserted in the field lens assembly of the photosystem prints index marks on each photomicrograph enabling measurements to be taken from the print. A Reichert-Jung micrometer slide of 2 mm divided into units of 0.01 mm is used to establish the lens correction factor for each magnification capability of the microscope.

Black and white or color film may be used, and processed privately or commercially. In this study, Kodacolor film was used to make 10×15 cm (4×6 inches) prints. For color transparencies, Kodak Tungsten film has been the film of choice. From the photographs, 25 each of adaxial cells, abaxial cells, guard cells (both as a unit) and subsidiary cells are measured using a set of calipers to measure average lengths and widths. The number of trichomes (adaxially and abaxially) shown on each photomicrograph is noted on the specimen's data sheet, as are the number of stomata.

A Macintosh SE/30 computer with 5 mb of RAM and 80 mb of internal memory was initially employed, augmented later by a Power Tower Pro 225 computer with 128 mb ram and 2 gb of internal memory. A Microsoft Excel spreadsheet combined each raw measurement with the lens correction factor, entering measurements on the data sheet in microns (μ) and combining them to present the total, mean, and standard deviation for each set of measurements. The statistical treatment used was an analysis of variance (ANOVA) with $p = .05$. The number of cells per square millimeter was computed and printed on the specimen's data sheet. Totals from each individual data sheet are linked to provide a combined worksheet from which data totals are analyzed, and individual and groups of Gaussian curves can be obtained on printouts.

RESULTS

Data have been collected from fifty *Stanhopea* specimens, 32 of which are different species (multiple samples of some), and two man-made primary hybrids. Data have also been collected from plants of *Govenia utriculata* (Sw.) Lindley, *Govenia superba* (Llave & Lexara) Lindley ex Loddiges, *Malaxis corymbosa* (S. Watson) Kuntze, and *Malaxis macrostachya* (Lexara) Kuntze in the Sierra Madre range southwest of Monterrey, Mexico. Subsequent checking indicates no damage done to any field or greenhouse plant from which leaf-prints have been taken.

A *Stanhopea* plant received as an "unknown" on 29 April, 1996 was numbered C26 and data taken from it were compared with that from known plants. Comparisons of the mean of its adaxial cell areas with known species ($r = .05$) indicated it as *S. tigrina*. On 20 June, 1996 another unknown arrived and was tagged C33. The data inferred that it too was *S. tigrina*. On 08 July plant C26 flowered, confirming the prediction made on the basis of the statistical data from the leaf print. This provided the first example of

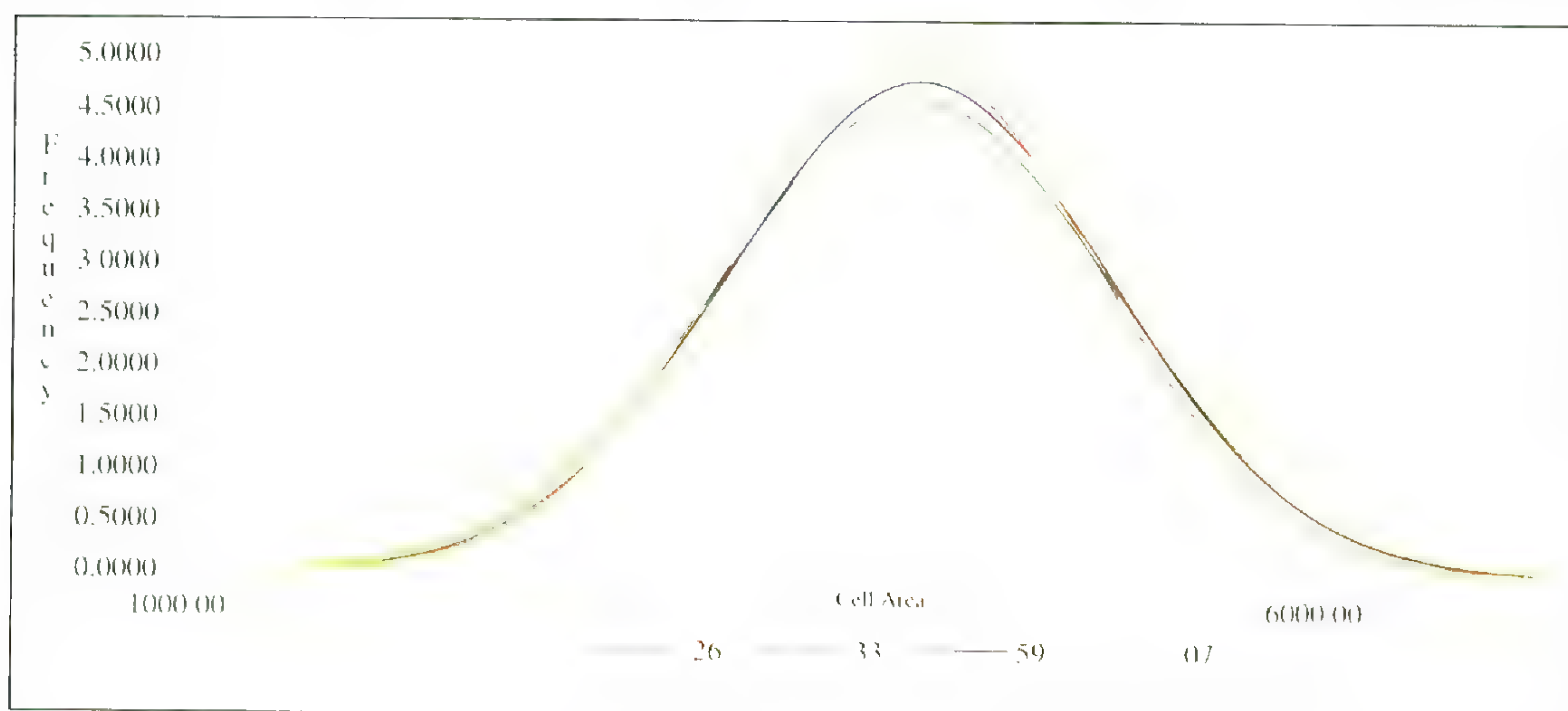


FIG. 1. Gaussian curves of adaxial cell areas of *S. tigrina* specimens C26, C33, C59, and C07.

the successful prediction of the plant's identity by use of this methodology prior to seeing it in flower. A few days later, despite the destruction of plant C33 by a resident macaw, analysis of the remains of a not-fully-opened flower confirmed that its predicted identification had also been correct. Gaussian curves are presented for plants C26 and C33 and the two confirmed *S. tigrina* plants (C07 and C59) in Figure 1.

Although the normal curve for specimen C26 was more leptokurtic (higher "crested") than the others, the adaxial means of all specimens did not significantly differ (ANOVA, $p = .05$). Amplified data for the four *Stanhopea tigrina* specimens is shown in Table 1.

Stanhopea Chocolate Chips = *S. tigrina* $\times$ *panamensis* by D. Pulley, 1991 (Fisher 1994). Data from specimen C56, Chocolate Chips 'Lindt' was compared with that from C07 *S. tigrina*, C59 *S. tigrina* 'Glory of Mexico,' and C58 *S. panamensis*, all of which were supplied by Dr. Douglas Pulley of Los Gatos, California. While the exact *S. tigrina* parent of this hybrid was unknown by this worker, all plants had been received from the same grower-hybridizer, and the assumption was that one of the two *S. tigrina* plants was one parent and the *S. panamensis* plant the other. Therefore both *S. tigrina* plants are included in the chart of the Gaussian curves and Table 2 gives a summary of the data for the four specimens.

DISCUSSION

Analysis of the adaxial cell area means of the hybrid and parents (Table 2) infers that *S. Chocolate Chips 'Lindt'* is vegetatively more closely allied with the *S. tigrina* parent than with *S. panamensis*. This is borne out pictorially by the position and shape of the curves (Figure 2), and abaxial epidermal cells indicate a similar relationship. However, correlation attempts using stomata guard and subsidiary cells have been inconsistent in and between

TABLE 1. Statistical data: Four specimens of *S. tigrina* (C07, C26, C33, & C59). Specimen C59 is *S. tigrina* 'Glory of Mexico.' Note that areas and numbers of cells are means derived from data collections. Ad: adaxial; StdDev: standard deviation; Ab: abaxial; Aad/Aab: area, adaxial/area, abaxial; GCl/w: guard cells length/width; SSarea: area, subsidiary cells; SSl/w: subsidiary cells length/width.

C#	Ad Area	Ad#Cells	AdStdDev	AbArea	Ab#Cells	AbStdDev	Aad/Aab	GCArea	GCl/w	SSarea	SSl/w
07	4259	234.79	852.13	2857.66	349.94	700.88	1.49	919.92	1.42	2126.08	1.50
26	4220	236.94	805.00	2856.17	320.12	734.29	1.48	1128.68	1.25	2159.94	1.30
33	4234	236.21	869.12	2816.88	355.00	815.48	1.50	1537.75	1.34	1483.57	1.25
59	4245	235.57	836.57	2917.18	342.80	639.82	1.46	1817.58	1.48	3745.29	1.25

TABLE 2. Statistical data: C07 *S. tigrina*, C59 *S. tigrina* 'Glory of Mexico,' C56 *S. Chocolate Chips* 'Lindt,' & C58 *S. panamensis*. Ad: adaxial; StdDev: standard deviation; Ab: abaxial; Aad/Aab: area, adaxial/area, abaxial; GCl/w: guard cells length/width; SSarea: area, subsidiary cells; SSl/w: subsidiary cells length/width.

C#	Ad Area	Ad#Cells	AdStdDev	AbArea	Ab#Cells	AbStdDev	Aad/Aab	GCArea	GCl/w	SSarea	SSl/w
07	4259	234.79	852.13	2857.66	349.94	700.88	1.49	919.92	1.42	2126.08	1.50
59	4245	235.57	836.57	2917.18	342.80	639.82	1.46	1817.58	1.48	3745.29	1.25
56	4095	244.19	850.31	2828.01	353.61	622.69	1.45	1566.14	1.30	3477.2	1.39
58	3724	268.50	822.46	2657.20	376.34	392.69	1.40	1541.51	1.32	1484.26	1.58

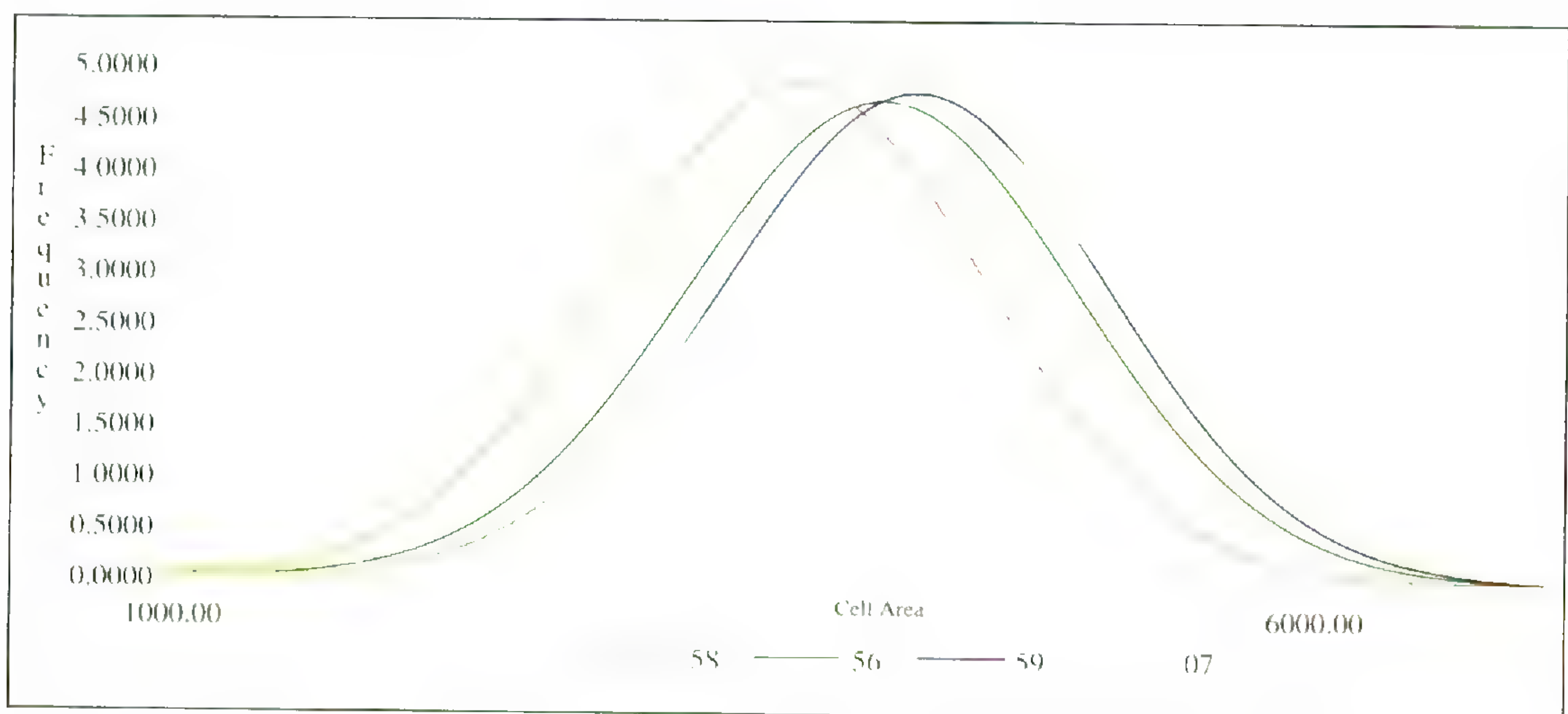


FIG 2. Gaussian curves of adaxial cell areas of C58 *S. panamensis*, C56 *S. Chocolate Chips 'Lindt,'* and *S. tigrina* specimens C59, and C07.

species as well as between species and their hybrids. More trials linking leaf cell data with proven floral qualities are indicated. If parent-offspring curves of adaxial cell areas or areas of other external organs can be correlated with specific floral qualities sought by the hybridizer, these results could be of economic value as a predictor of floral characteristics while still in the seedling stage and could afford the grower improved quality control over seedling crops. With regard to taxonomic avenues, it is hypothesized that the statistical relationship established by DNA sequencing will not significantly differ from that arrived at by this methodology. If this proves to be the case with botanical specimens, a vast array of possibilities may be applicable to other life forms.

The identification of these unknowns offers encouragement for the greater use of this leaf-print-statistical analysis methodology for confirming plant identities in nature, and preliminary field studies lend support to the use of this methodology. Adapted for field use, population surveys appear to be possible without disrupting the ecosystem, while affording humans the option of hand-pollinating specifically identified field plants, thus assisting in reviving a low plant population without disturbing its members.

In the field, this system could be of use in confirming the identity of both species and hybrids and provide the number of each in specific areas. Grant's work (1981) with the genus *Gilia* in California provides strong evidence that—with sufficient time and the invasion and adaptation of a species into new habitats—a species can vary sufficiently over its range to provide new fixed gene combinations resulting in a new species. Grant's basic data was originally published in 1971 with the 1981 edition providing refinements, corrections, additional data, and preliminary results of unpublished clinical work with specimens of *S. saccata* and *S. radiosa* ap-

pear to provide confirmation for his work. In light of the work of Dodson (1963) and of Kennedy (1975), it is suggested that field identification work using this statistical methodology over the range of the *Stanhopea radiosa-saccata* complex would provide useful data for clarification of this speciation phenomenon and assist in establishing specific points of variation at precise locations over the geographical range of the two species.

In conclusion, this is an objective approach to plant identification confirmation relying on data capable of statistical verification. In outlining the six requirements listed earlier in this paper, the attempt has been to detail a system workable within the realities of governmental attitudes, and the conservation desires of the scientist; yet one capable of being easily understood and supported politically and economically by government agencies and local people within the countries concerned.

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SUGGESTED MODIFICATIONS OF THE SALISBURY STOMATA INDEX DEvised FROM A STUDY OF *STANHOPEA* (ORCHIDACEAE)

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ABSTRACT

Calculations of the stomata index have resulted in wide variances in indices both single and between plants. Modification of the formula is suggested, including a method of more accurately estimating stomata and subsidiary cells, with accuracy capable of being checked by the use of an identity involving adaxial and abaxial leaf surfaces.

RESUMEN

Los cálculos del índice estomático dieron variaciones amplias, tanto en un individuo como entre diferentes plantas. Se sugiere la modificación de la fórmula, para incluir un método de cálculo más seguro de estimación de estomas y células subsidiarias, con una precisión capaz de ser comprobada por el uso de una identidad que abarque las superficies del haz y el envés de las hojas.

INTRODUCTION

When initiating our investigation of the role of stomata in water loss from leaves of members of the genus *Stanhopea* (Orchidaceae) we approached this problem by initially attempting to determine the stomatal density in a given area of leaf surface. However, results were inconclusive despite attempts to ameliorate variations by recording stomatal frequency in terms of the stomata to the proportion of epidermal cells as suggested by Stace (1965). Sinclair (1990) expressed preference for the use of the stomata index (SI) of Salisbury (1928) over the mere determination of stomatal density. This index is arrived at by adding the number of epidermal cells to the number of stomata, dividing this into the number of stomata, and multiplying the result by 100.

Stace (1965) as well as Metcalf and Chalk (1979), working with dicotyledonous material, found this index to be quite variable both in single plants and between plants. The rationale given for this variability was that although a leaf developing under water stress retains the total number of epidermal cells, the cells are smaller, with the result that stomatal density increased in the stressed leaf. Conversely, Rowson (1943 a, b, 1946), ci

in Metcalf and Chalk (1979), working with the genus *Cassia* (Fabaceae), concluded that species of the same genus may be differentiated by means of the stomatal index. Rowson also found that the stomatal index: (a) did not vary significantly at different positions upon the leaf surface; (b) was independent of leaf size and habitat; and (c) was the same for different varieties within a species. Working with monocotyledons, Singh and Singh (1974) report an SI range of 2.0–17.0 for seven species of epiphytic orchids, and Boros (1980) reports 2.5–30.3 for 11 species of terrestrial orchids.

Rasmussen (1987) mentions *Stanhopea* only casually, stating that a species (*S. tigrina*) was included in a summary by Strasburger (1866–67). Similarly, reviewing water relations in orchids, Sinclair notes the genus once as a reference by Link (1849) who saw spirally thickened idioblasts in roots of *Stanhopea ebornea* (Link's spelling = *eburnea*). Other than these casual references, data is scant concerning *Stanhopea* stomatal complexes.

During normal development, members of this genus receive copious water. Thus, they should exhibit stomata indices not greatly different from one another. However, use of the Salisbury formula yields inconclusive data when calculating a baseline stomata index for individual species (see SI_{cells}: Table 1). With wide ranges reported by previous workers and the minimal data regarding this genus, a closer look at the formula was indicated.

The stomata index formula assumes that the leaf surface displays epidermal cells and stomata within a given area, and given the material with which Salisbury worked, this assumption is both obvious and quite correct. However, the literature is unclear regarding whether certain epidermal cells (trichomes and their flanking cells) are excluded, included as a unit, or counted as individual entities. Additionally, the literature is unclear whether stomatal subsidiary cells are counted separately or included as an entity of the stomatal complex. Thus, applying this as a general formula may not allow for other organs on the leaf surface, and results may be correct or merely the product of a mathematical error. In *Stanhopea* plants trichomes are present on both adaxial and abaxial leaf surfaces, with stomata only on the abaxial surface with the stomata are flanked by paracytic subsidiary cells. Thus, in order to arrive at a more accurate measure of the stomata index, the leaf surface space taken by these epidermal organs should be considered. However, counting the number of stomata within a given area leads to estimates when several of these organs overlap the borders of the selected area, and thus inaccuracies can be introduced in the number of stomata actually represented in that area of the leaf surface. Additionally, the basic formula does not clearly consider variances in the sizes of subsidiary cells.

METHODS AND MATERIALS

Photomicrographs of the leaf surface were taken and a random sample (N = 25) of adaxial cells, abaxial cells, stomata guard cells, and individual

subsidiary cells was measured and the mean of each is shown in the table. Although the number of cells varies, the adaxial leaf area is equal to its abaxial area. Hence this identity can be expressed, using areas instead of numbers of cells, as shown in formula (1):

$$(1) Ad_{\text{cells}} + Ad_{\text{trichomes}} = Ab_{\text{cells}} + Ab_{\text{trichomes}} + \text{Stomata} + \text{Subsidiary Cells}$$

The number of trichomes in these *Stanhopea* plants number only one or two in a standard area, resulting in a negligible difference in the adaxial and abaxial areas. Thus their effect has been assumed as equal and they are dropped from these calculations. However, where trichomes are numerous or adaxial and abaxial quantities differ greatly, their numbers and areas should be included in calculations. With this modification, the identity is expressed as in formula (2).

$$(2) Ad_{\text{cells area}} = Ab_{\text{cells area}} + \text{Stomata}_{\text{area}} + \text{Subsidiary Cells}_{\text{area}}$$

Using the random sample of 25 epidermal cells, another modification is necessary to arrive at an accurate number of stomata complexes. As each set of *Stanhopea* guard cells is supported by two paracytic subsidiary cells, the identity becomes as shown in formula (3).

$$(3) 25 (Ad_{\text{cells area}}) = 25 (Ab_{\text{cells area}}) + X [\text{Stomata}_{\text{area}} + 2 (\text{Subsidiary Cells}_{\text{area}})].$$

Entering numerical values (e.g. C#01, *S. saccata*) gives:

$$(3a) 25 (3097.40) = 25 (2219.28) + X [1476.94 + 2 (2024.48)].$$

Thus the number of stomata (X) within the specified area = 3.973.

Inserting this value into the modified Salisbury formula gives the following:

$$SI = \frac{S}{E+S} = \frac{\#St[\text{areaSt}+2(\text{areaSS})]}{E+\#St[\text{areaSt}+2(\text{areaSS})]} = \frac{3.973[1476.94+2(2024.48)]}{25(2219.28)+3.973[1476.94+2(2024.48)]} = \frac{21.954}{77436.4}$$

$$\text{and} \quad SI = 0.284$$

Merely counting the number of stomata complexes within a specified area introduced inaccuracies due to variances in guard cell sizes, as well as stomata overlapping area boundary lines, and exclusion of the areas of subsidiary cells. These counts produced false stomata indices as shown in the column headed SI Cell, and thus showed greater differences between plants of the same species as well as of different species of the same genus. Using the number of abaxial cells per square millimeter (e.g. C01 *S. saccata* = 450.6), and the number of stomata (3.973) in the classic formula gives the index as shown in formula (4):

$$(4) \quad SI = \frac{S}{E+S} \times 100 = \frac{3.973}{450.6 + 3.973} \times 100 = 0.874$$

RESULTS

TABLE 1. Summary of 30 *Stanhopea* species. Ad Area: mean adaxial cell surface area; Ab Area: mean abaxial cell surface area; Ab Cells: abaxial cells p/sq mm; # Stoma: mean number of stoma p/sq mm; GC Area: mean area of guard cells; SS Area: mean subsidiary cell area; SI Cell: index per Salisbury formula; SI Area: index per modified formula

C# Species	Ad Area	Ab Area	Ab Cells	# Stoma	GC Area	SS Area	SI Cell	SI Area
01 <i>saccata</i>	3097.40	2219.28	450.60	3.973	1476.94	2024.48	.874	.284
02 <i>saccata</i>	3040.90	2219.09	450.64	3.715	1264.14	2133.04	.817	.270
03 <i>insignis</i>	4769.92	3247.80	307.90	6.567	1993.45	1900.39	2.088	.319
04 <i>hernandezii</i>	2782.83	2096.11	477.07	4.202	1291.47	1397.28	.873	.247
05 <i>oculata</i>	4123.24	2574.44	388.43	9.18	1476.80	1581.22	3.055	.376
06 <i>oculata</i>	4173.52	2535.24	394.44	8.50	1554.22	1632.02	2.110	.393
07 <i>tigrina</i>	4259.11	2857.66	349.94	6.774	919.92	2126.08	1.899	.329
08 <i>graveolens</i>	3380.38	2372.18	421.55	3.698	1467.43	2859.74	.870	.298
09 <i>graveolens</i>	3288.62	2309.55	432.98	5.93	1518.74	1400.99	1.351	.297
10 <i>martiana</i>	3744.41	2700.86	370.25	5.837	1215.20	1627.29	1.552	.288
11 <i>intermedia</i>	2694.32	2060.25	485.38	2.888	1318.93	2085.25	.591	.235
12 <i>wardii</i>	4603.10	3546.56	281.96	4.799	1302.88	2100.33	1.673	.230
13 <i>wardii</i>	4594.98	3526.38	283.58	6.004	1568.32	1440.43	2.073	.233
14 <i>wardii</i>	4660.02	3570.86	280.04	5.092	1343.93	2001.75	1.786	.234
15 <i>nigroviolacea</i>	3129.27	2263.86	441.72	4.982	1137.87	1602.38	1.115	.277
16 <i>insignis</i>	4780.59	3251.88	307.51	7.176	1287.34	2019.38	2.290	.319
17 <i>costaricensis</i>	3605.70	2648.90	377.52	4.412	1427.67	1997.20	1.155	.265
18 <i>pozoi</i>	4891.37	2991.96	334.23	10.542	1520.17	1492.10	3.058	.388
19 <i>shuttleworthii</i>	4377.18	2808.95	356.01	7.304	1334.66	2016.36	2.010	.358
20 <i>tricornis</i>	4532.35	3555.51	281.25	5.077	1181.80	1813.87	1.773	.216
21 <i>reichenbachiana</i>	5623.69	3766.63	265.49	11.819	1337.21	1295.46	4.262	.330
22 <i>eburnea</i>	4498.03	3726.32	268.36	3.157	1419.09	2346.20	1.163	.172
23 <i>ecornuta</i>	3837.05	2756.76	362.75	4.838	1450.68	2065.54	1.316	.282
24 <i>jenischiana</i>	4368.36	2899.41	344.90	5.508	1360.17	2653.54	1.572	.336
25 <i>grandiflora</i>	4816.54	3714.49	269.22	8.525	1222.81	1004.59	3.069	.229
26 <i>tigrina</i>	4220.15	2856.17	350.12	6.258	1128.68	2159.94	1.756	.323
27 <i>candida</i>	4856.62	2790.16	358.40	11.420	1355.76	1584.00	3.088	.425
28 <i>connata</i>	4713.00	3213.80	311.16	6.833	1477.35	2003.84	2.149	.318
29 <i>baselowania</i>	4215.97	3556.07	281.21	2.295	1471.04	2858.26	.810	.157
30 <i>impressa</i>	4307.50	3119.53	320.56	10.26	1072.09	1228.61	3.101	.276

DISCUSSION

Although the area method involves more calculations, it provides a more accurate indication of the stomata and subsidiary cells within a given leaf surface area. While the number of cells varies on both the adaxial and abaxial leaf surfaces, obviously the *areas* of the leaf surfaces should be equal as should the sums of the areas of the organs on each surface. The literature is silent concerning subsidiary cells in calculations of the stomata index, but these cells occupy significant areas of the abaxial leaf surface in *Stanhopea* as well as other monocotyledons. In *Stanhopea*, stomata and subsidiary cells occur only on the abaxial leaf surface, with the guard cells of all species surveyed accompanied by subsidiary cells of varying areas. However, this does not

hold true for all other plants or even all members of the Orchidaceae, and particular attention should be paid to modification of the general formula in order to properly reflect the particular physiological condition of the plants being analyzed.

Previous workers have reported wide ranges of the stomata index in and between plants of the same species. However, in this survey of 50% of this genus the stomata index is not significantly different for plants of the same species, nor is a wide range observed between different species. It is suggested that calculations of the stomata index include subsidiary cells and any other types included in the count, as well as noting them as such. It is also suggested that the stomata index formula be modified to consider the areas of all components rather than being calculated by merely a count of unspecified epidermal cells and only the guard cells of stomata.

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BOOK REVIEW

BERLIN, ELOIS ANN and BRENT BERLIN. 1996. **Medical Ethnobiology of the Highland Maya of Chiapas, Mexico.** (0-691—03741-8, cloth). Princeton University Press, Princeton, N.J. \$85.00. 557 pp.

The Tzeltal and Tzotzil Maya in the highlands of Chiapas, Mexico have been in the forefront of paradigm development as the interdisciplinary field of ethnobiology matures. Contributions to understanding the principles of classification and taxonomy made through the systematic study of these indigenous peoples has probably accomplished more than all systematic lists of useful plants and animals published since Castetter defined the field. The authors and collaborators document a system of traditional knowledge based on years of explicit empirical experimentation about the effects of herbal remedies on body function. The authors provide an ethnomedical characterization of gastrointestinal conditions recognized by these highland Maya and describe existing evidence on the pharmacological activity of thirty-four medicinal plant species used to treat gastrointestinal diseases by the highland Maya. The authors claim that existing evidence on the pharmacological activity of plant species used in the treatment of gastrointestinal ailments of the Highland Maya supports the notion that these indigenous people have a scientific basis for traditional medicine possessing well-developed therapeutic efficacy.

The authors have gone to great lengths to document the cultural understanding of illness including cause, treatment and prognosis and is surely the most thoroughly researched ethnomedical characterization of gastrointestinal illness to date. The thoroughness of ethnomedical research on each of three major gastrointestinal conditions—diarrheas, abdominal pains and worms—is complemented by description of the documented biological activities of the principal medicinal plants used to treat each gastrointestinal affliction. Details of known biological activities of thirty-eight species comprising the “basic medicine kit” (*el cuadro básico*) is supplemented with an evaluation of an additional fifty-seven species used in admixtures with the basic medicine kit. Evaluation of a subset of the plant species used in admixtures further support to the idea that these indigenous people possess a sophisticated understanding of complementary or intensifying nature of biological activities of the admixtures used in treating gastrointestinal conditions among the highland Maya.

This book marks the maturation of ethnobiological inquiry in which attention is focused as much on demonstrating the scientific basis of indigenous health care as on documenting efficacy of traditional treatment of illness. In the context of growing interest in self-determination among indigenous groups and sovereign rights over knowledge about use of biological diversity, this book goes further than any other in demonstrating how academic research can also satisfy local community interests and needs. This information-packed volume should be on the bookshelf of all who would consider biological prospecting in forests possessed by indigenous societies because it provides a benchmark method that can help to empower local communities to assume responsibility in the conservation of biological and cultural heritage.—*Bruce Benz.*

A SYNOPSIS OF THE GENUS *GENTLEA* (MYRSINACEAE) AND A KEY TO THE GENERA OF MYRSINACEAE IN MESOAMERICA

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ABSTRACT

An updated description of the genus *Gentlea* and its taxonomic synonyms is provided, along with a key and a nomenclatural summary for its nine species. Nine binomials are newly relegated to synonymy, and three taxa are excluded. *Heberdenia* Banks, once thought to occur in the Neotropics, is shown to be monotypic, and known only from the Canary Islands, necessitating the new combination *Gentlea penduliflora* (A. DC.) Ricketson & Pipoly. To facilitate identification of members of the genus *Gentlea*, a key to the genera of Mesoamerican Myrsinaceae is also provided.

RESUMEN

Se aporta un resumen nomenclatural para las nueve especies del género *Gentlea*. Se incluye una descripción actualizada del género con una clave para separar las especies. Se comprobó que el género *Heberdenia* es monotípico, y restringido a las Islas Canarias, resultando la nueva combinación *Gentlea penduliflora* (A. DC.) Ricketson & Pipoly. Para facilitar la identificación del género, se ofrece una clave para separar los géneros mesoamericanos de la familia Myrsinaceae. También se ofrece una clave para todos los taxa del género *Gentlea*, se enumeran sinónimos tanto nomenclaturales como taxonómicos. Se relegan nueve binomios a la sinonimia, y se excluyen tres taxa del género.

INTRODUCTION

The neotropical genus *Gentlea* Lundell, as here circumscribed, comprises nine species, ranging from Mexico to Peru. The genus occurs primarily in upper cloud and elfin forest formations, and is defined by long exerted stamens with minute dorsifixed cordate anthers, an elongated style, and terminal inflorescences that are short-pedunculate or subsessile, and when paniculate, generally broader than long. The genus has been confused with

Cybianthus and with *Ardisia*, but given the confusion surrounding generic delimitation in the family, we present a key to all Mesoamerican genera below.

KEY TO GENERA OF MYRSINACEAE IN MESOAMERICA

1. Calyx closed in bud, irregularly opening into 2–8 lobes within the same inflorescence. **Geissanthus**
1. Calyx open in bud, opening into (3–)4–5(–6) lobes, the number of calyx lobes per flower consistent within one inflorescence.
 2. Calyx and corolla lobe valvate in bud.
 3. Flowers bisexual; inflorescences paniculate, longer than the petioles; branchlets tomentose with stellate or dendroid trichomes; calyx and corolla tomentose and glandular-papillose; anthers bright yellow; style elongate. **Parathesis**
 3. Flowers unisexual; inflorescences glomerulate, umbellate or rarely in reduced corymbs, much shorter than the petioles; branchlets glabrous or when tomentose, then with simple trichomes; calyx and corolla glabrous or the corolla sometimes glandular-papillose along the margin within; anthers cream to white; style obsolete or reduced. **Myrsine**
 2. Calyx and corolla quincuncial, imbricate (although sometimes inconspicuous) or contorted in bud.
 4. Filaments connate basally to form a staminal tube adnate to the corolla tube.
 5. Inflorescence lateral (axillary); corolla tube glandular-granulose at least at the junction of the tube and lobes. **Cybianthus**
 5. Inflorescence terminal; corolla tube glandular-puberulent at base. **Synardisia**
 4. Filaments free from each other and free from or variously adnate to the corolla tube.
 6. Filaments adnate to the corolla; anthers less than 3 times longer than wide.
 7. Filaments exerted, more than 6 times longer than the anthers; plants of elfin and cloud forests. **Gentlea**
 7. Filaments included, shorter than or as long as the anthers; plants of montane to lowland forests. **Stylogyne**
 6. Filaments free from corolla; anthers at least 3 times longer than wide.
 8. Petals connate 1/4 their length; ovules uniseriate, the placentation free-central. **Ctenardisia**
 8. Petals connate up to 1/5 their length; ovules pluriseriate, the placentation basal. **Ardisia**

In preparing a treatment of the genus for *Flora Mesoamericana*, it became necessary to assemble complete synonymies and bibliographic references for *Gentlea*. Because of the somewhat abbreviated format of the *Flora*, the present synopsis is intended to provide a complete nomenclator for *Gentlea*, which has been poorly understood.

TAXONOMIC TREATMENT

Gentlea Lundell, *Wrightia* 3:100. 1964. TYPE SPECIES: *Gentlea venosissima* (Ruíz & Pavón) Lundell. *Ardisia* Swartz subgen. *Walleniopsis* Mez in Engl., *Pflanzenr.* IV. 236 (Heft 9):77. 1902.

Dioecious *shrubs* or small trees. *Leaves* alternate, petiolate. *Inflorescences* terminal, paniculate with corymbose branches, broader than long, short-pedunculate or subsessile, rarely umbellate or a reduced to a solitary flower; floral bracts thin, caducous. *Flowers* 4(–6)-merous, unisexual, pedicellate; sepals inconspicuously imbricate, connate basally or nearly free; petals connate 1/4–1/2 their length into tube, the lobes imbricate in bud, spreading and sometimes appearing valvate at anthesis; stamens exserted, the filaments long and slender, more than 6 times longer than the anthers, the anthers minute, cordate, dorsifixed, epunctate or inconspicuously glandular-punctate dorsally; pistil ovoid or subglobose, the style slender, shorter or sometimes subequalling the corolla, the stigma punctiform, minute; ovules few to many, in 2 or more series. *Fruit* subglobose, one-seeded, exocarp thin, often drying costate.

A small distinctive genus of nine species ranging from Jalisco, Mexico to Venezuela, Colombia and Peru. Members of the genus occur in upper cloud and elfin forest formations. *Gentlea* can be confused with *Ardisia* in fruit, except that the inflorescence of those with panicles is wider than long (rare in *Ardisia*), and the fruit is either inconspicuously or conspicuously costate (smooth in *Ardisia*).

KEY TO SPECIES OF *GENTLEA*

- 1. Inflorescence umbellate or rarely a solitary flower 1. *G. penduliflora*
- 1. Inflorescence paniculate.
 - 2. Leaf blades elliptic or rhombic, densely lepidote below, the margin slightly to deeply crenulate in the distal 1/2. 2. *G. vatteri*
 - 2. Leaf blades oblanceolate, obovate or oblong, glabrous or with scattered trichomes below, of various shapes except lepidote scales, the margin entire to crenulate or serrate with teeth uniform throughout.
 - 3. Inflorescence rachis and pedicels glabrous.
 - 4. Leaf margins entire 3. *G. standleyi*
 - 4. Leaf margins crenulate to serrulate.
 - 5. Leaf margins crenulate; petals translucent-lepidote abaxially. 4. *G. crenulata*
 - 5. Leaf margins serrulate; petals glabrous abaxially. 5. *G. tacanensis*
 - 3. Inflorescence rachis and pedicels glabrate, with a few scattered furfuraceous scales or simple, glandular trichomes, or tomentose with simple or dendroid trichomes.
 - 6. Inflorescence rachis and peduncle tomentose, with a dense mat of simple or dendroid hairs.
 - 7. Leaf blades chartaceous, 0.5–1.5(–1.8) cm wide, inconspicuously

- pellucid-punctate, the secondary and tertiary veins inconspicuous; sepals 0.8–1.2 mm long. 6. *G. lancifolia*
7. Leaf blades stiffly chartaceous to subcoriaceous, (1.5–)2.0–6.0 cm wide, prominently black punctate abaxially, the secondary and tertiary venation prominently raised; sepals 1.5–2 mm long. 7. *G. venosissima*
6. Inflorescence rachis and peduncle glabrate, with a few appressed or erect, scattered, simple or sessile glandular trichomes.
8. Pedicels with appressed glandular trichomes; sepals 1.2–1.8 mm long; petals 5–6 mm long; leaf blades 2–6(–8.5) cm long, 1–2.5 (–3.5) cm wide. 8. *G. austinsmithii*
8. Pedicels with mostly erect, simple or glandular hairs; sepals 2–3 mm long; petals 3.5–4.2 mm long; leaf blades (7.5–)10–23 cm long, (2.5–)4.5–6.5 cm wide 9. *G. micranthera*
1. ***Gentlea penduliflora*** (A. DC.) Pipoly & Ricketson, comb. nov. *Myrsine penduliflora* A. DC., Trans. Linn. Soc. London 17:110. 1834. *Heberdenia penduliflora* (A. DC.) Mez in Engl., Pflanzenr. IV. 236 (Heft 9):159. 1902. TYPE: *Calques Fl. Mexique* t. 739. 1874 (HOLOTYPE: G, F! as photo- f neg. no. 30749).

Upon review of the genus *Gentlea*, it became obvious that *Heberdenia penduliflora* could not be separated from it except for the inflorescence type. Further examination of the type of *Heberdenia excelsa* revealed that there were significant differences between that taxon and *H. penduliflora*. Therefore, transfer of *Heberdenia penduliflora* to *Gentlea* leaves *Heberdenia* a monotypic genus known primarily from the Canary Islands. *Heberdenia*, as here circumscribed, is characterized by having included stamens with filaments adnate to the corolla 1/2 their length and dorsifixed, reflexed anthers; greenish petals thick and “leathery,” with few black punctations, and the adaxial surface densely covered with very short papillae. While *Heberdenia excelsa* superficially shares leaf and inflorescence characters with *Gentlea penduliflora*, the latter differs from the former in having exerted stamens with minute, erect, dorsifixed anthers and finally, membranaceous petals, with conspicuous reddish or black punctations, pink-white in color, and glabrous throughout.

Despite the fact that *Gentlea penduliflora* differs from the rest of the species in the genus by its inflorescence of umbellate flowers or rarely a solitary flower, versus a paniculate inflorescence in other members of the genus, but its exerted stamens with minute, dorsifixed anthers, elongated style, and costate fruit indicate it is well placed in *Gentlea*. There are various examples of species in other genera with markedly reduced inflorescence structures, such as *Myrsine laetevirens* (Mez) Arechav., the only *Myrsine* with an abbreviated raceme, *Stylogyne membranacea* Pipoly, the only *Stylogyne* with two-flowered corymbs, *Cybianthus fabiolae* Pipoly, the only *Cybianthus* with one flower or a two-flowered raceme appearing umbelliform, and

Ctenardisia stenobotrya (Standley) Pipoly & Lundell, the only *Ctenardisia* whose panicles bear flowers in umbels.

In attempting to locate the type of *Gentlea penduliflora*, study of the results from the Royal Botanical Expedition to Mexico led by Don Martín de Sessé and José Mariano Mociño between 1787 to 1804 was necessary. Results from that expedition are well chronicled by Barkley (1945), Rickett (1947), Wilson (1962), Arias Divito (1968) and McVaugh (1977, 1980, 1982). The expedition collected specimens that are housed at MA and their duplicates were later distributed by Pavón. However the most outstanding contribution of the expedition was the commissioning of 2,000 watercolored drawings of Mexican plants and animals. Work on the collections and drawings was slowed after the return of Sessé, the principal investigator, to a Spain in political turmoil, and his subsequent death in 1809. Mociño gave Augustin Pyramus de Candolle a number of duplicate drawings and lent him his manuscripts and the original drawings in 1813 when he was forced to take asylum in France. Approximately 1,000 color "copies" were made of the original drawings before they were returned with Mociño to Spain. Unfortunately, the original drawings disappeared after the death of Mociño in 1819 and were not rediscovered until the 1970s when they were acquired by the Hunt Institute for Botanical Documentation in Pittsburgh, Pennsylvania. A significant number of new genera and species are based on the collections that were released by MA and the copies made by A.P. de Candolle between 1803 and 1874. Alphonse de Candolle (1874) distributed 10 sets of tracings of the color copies of the original made by his father in 1817. Finally, two posthumous works of Sessé and Mociño, *Plantae Novae Hispaniae* and *Flora Mexicana*, were published between 1887 and 1894, nearly a century after the expedition occurred.

The above information is used to help illustrate the difficulty in tracking down the type of *Gentlea penduliflora*. Alphonse de Candolle first described this taxon in 1834 based on "Icon. Mexic. ined.," the Sessé and Mociño drawings. In his treatment of the Myrsinaceae for the DC. Prodrômus (1844), Alphonse lists only "Ex ic. ined. n. 739. fl. mexic." It seems fairly clear that Alphonse de Candolle based this name solely on the color copy in Geneva, since it appears that no actual collection is housed presently at G from that period and it is unlikely that he studied the Sessé and Mociño Herbarium in Spain. Therefore, this is a holotype and no lectotypification is needed. The first plant collections at G do not appear until the 1840s. In addition, since the originals disappeared for over 150 years and Alphonse de Candolle was only 10 years old when the originals were returned to Spain, it is unlikely that they could have been used to describe the taxon 17 years later. Comparison of the original drawing at

Hunt and the copy in Geneva are very similar with only slight, non-essential differences, owing to differences in the portions painted. Thus, we select the original color copy in Geneva (t. 739) as the lectotype. This drawing was photographed by the Field Museum of Natural History (Neg. No. 30749) and photo's are widely distributed in many herbaria. Unfortunately, the original drawing now housed in the Torner Collection at the Hunt Institute for Botanical Documentation at the Carnegie Mellon University in Pittsburgh, Pennsylvania, becomes nomenclaturally irrelevant.

Distribution and ecology.—*Gentlea penduliflora* is infrequent in pine-oak forests on steep slopes and along montane watercourses, 1,400–2,900 m elevation. It is endemic to Mexico, in the states of Queretaro, Hidalgo, Puebla, Veracruz, Oaxaca and Chiapas.

2. ***Gentlea vatterii*** (Standl. & Steyererm.) Lundell, *Wrightia* 3:102. 1964. *Ardisia vatterii* Standl. & Steyererm., Publ. Field Mus. Nat. Hist., Bot. Ser. 23:220. 1947. TYPE: GUATEMALA. HUEHUETENANGO: Cerro Huitz, between Mimanhuitz and Yulhuitz, Cerro de los Cuchumatanes, 1,500–2,600 m, 14 Jul 1942 (fl), J.A. Steyermark 48558 (HOLOTYPE: F!; ISOTYPE: US!).

Distribution and ecology.—*Gentlea vatterii* is locally common in the wet cloud forests of Guatemala and El Salvador, at 1,500–3,300 m elevation.

3. ***Gentlea standleyi*** Lundell, *Wrightia* 4:69. 1968. *Ardisia standleyi* (Lundell) Lundell, *Phytologia* 61:67. 1986. TYPE: COSTA RICA. HEREDIA: Cerros de Zurquí, NE of San Isidro, 2,000–2,400 m (fr), 03 Mar 1926, P.C. Standley & J. Valerio 50613 (HOLOTYPE: US!; ISOTYPE: LL-TEX!).

Ardisia minor Standl., J. Wash. Acad. Sci. 17:522. 1927, nom. illeg. non King & Gamble, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 74:146. 1906. Syn. nov. *Gentlea minor* (Standl.) Lundell, *Wrightia* 3:104. 1964, nom. illeg. *Gentlea costaricensis* Lundell, *Wrightia* 6:115. 1980. TYPE: COSTA RICA. HEREDIA: Cerro de Zurquí, NE of San Isidro, ca. 2,200 m (fr), 03 Mar 1926, P.C. Standley & J. Valerio 50571 (HOLOTYPE: US!).

Distribution and ecology.—*Gentlea standleyi* is endemic to Costa Rica, growing in premontane wet forests, at 1,100–2,400 m elevation.

The type of *Ardisia minor* was collected from the same locality, on the same day as was the type of *Gentlea standleyi*, and differs only slightly in appearance. Lundell failed to compare his *Gentlea costaricensis* to *Gentlea standleyi*.

4. ***Gentlea crenulata*** Lundell, *Wrightia* 6:96. 1979. *Ardisia contrerasii* Lundell, *Phytologia* 61:63. 1986, non *Ardisia crenulata* C. Lodd., Bot. Cab.1: t. 2. 1817, non *Ardisia crenulata* Vent., Choix Pl., 5, t. 5. 1803. TYPE: GUATEMALA. BAJA VERAPAZ: Niño Perdido, bordering Río San José, 8 km N, in high forest, on top of hill, 27 May 1977 (fl, fr), C.L. Lundell & E. Contreras 21004 (HOLOTYPE: LL-TEX!; ISOTYPES: CAS!, LL-TEX! -2 SHEETS,).

Distribution and ecology. —Because it is endemic to Guatemala and known

only from the type collection, there is a dearth of information about its ecology.

5. *Gentlea tacanensis* (Lundell) Lundell, *Wrightia* 3:105. 1964. *Ardisia tacanensis* Lundell, Contr. Univ. Michigan Herb. 4:21. 1940. TYPE: MEXICO. CHIAPAS: west side of Volcán de Tacaná, 2,800 m, 30 Mar 1939 (fl), E. Matuda S-226 (HOLOTYPE: MICH!; ISOTYPES: A!, F!, LL-TEX!, NY!, US!).

Distribution and ecology.—Wet montane evergreen cloud forests, 1,300–3,000 m elevation. Endemic to the area around Volcán Tacaná on the Chiapas, México-San Marcos, Guatemala border and Volcán Tajumulco in Guatemala.

6. *Gentlea lancifolia* Lundell, *Phytologia* 58:273. 1985. *Ardisia intibucana* Lundell, *Phytologia* 61:65. 1986, non *Ardisia lancifolia* Merr., Philipp. J. Sci. 13:113. 1918. TYPE: HONDURAS. INTIBUCA: between Calaveras and El Duraznillo, cordillera Opalaca, 1,800 m, 12 Mar 1970 (fr), A. Molina R. & A.R. Molina 25547 (HOLOTYPE: F!; ISOTYPE: US!).

Distribution and ecology.—Montane rain forest to elfin forest and cloud forests, 800–1,800 m elevation. Honduras and Nicaragua.

7. *Gentlea venosissima* (Ruíz & Pavón) Lundell, *Wrightia* 3:103. 1964. *Caballeria venosissima* Ruíz & Pavón, Syst. Veg. Fl. Peruv. Chil. 282. 1798. *Myrsine venosissima* (Ruíz & Pavón) Spreng., Syst. Veg. 1:664. 1825. *Ardisia venosissima* (Ruíz & Pavón) J.F. Macbr., Fieldiana, Bot. 13:186. 1959. TYPE: PERU. HUÁNUCO: Muña, without elevation, 1878–1888, (fl, fr), H. Ruíz & J. Pavón 5/37 (HOLOTYPE: MA, n.v., F Neg. 29508!).

Ardisia propinqua Kunth in H.B.K., Nov. Gen. Sp. 7:213. 1825. Syn. nov. *Gentlea propinqua* (Kunth) Lundell, *Wrightia* 4:166. 1971. TYPE: VENEZUELA. Crescit juxta ripam fluminis Orinoci, without elevation or date (fr), Humboldt & Bonpland s.n. (HOLOTYPE: P-BON!; ISOTYPE: P-BON, F! as photo-F Neg. 38723!).

Ardisia breviflora A. DC., Prodr. 8:122. 1844. *Tinus breviflora* (A. DC.) Kuntze, Revis. Gen. Pl. 2:974. 1891. TYPE: PERU. HUÁNUCO: Muña, without elevation or date (fr), J. Pavón (HOLOTYPE: G-BOIS, n.v., F! as photo-F Neg. 8524; ISOTYPES: F!, MA, n.v.).

Ardisia robinsonii Mez in Engl., Pflanzenr. IV. 236 (Heft 9):77. 1902. TYPE: VENEZUELA. MIRANDA-ARAGUA: between Caracas and Colonia Tovar [prope coloniam Tovar], 6,000 ft [1,829 m], 26 Mar 1857 (fl), A. Fendler 2357 (HOLOTYPE: GH!).

Ardisia meiantha Donn. Smith, Bot. Gaz. 44:115. 1907. TYPE: COSTA RICA. CARTAGO: vicinity of Cartago, 1,500 m, 19 Apr 1906 (fl), W.R. Maxon 44 (HOLOTYPE: NY!; ISOTYPES: US 2 SHEETS!).

Stylogyne phaenostemona Donn. Sm., Bot. Gaz. 46:113. 1908. *Ardisia phaenostemona* (Donn. Sm.) Lundell, *Wrightia* 3:78. 1964. TYPE: GUATEMALA. ALTA VERAPAZ: Coban, 1,350 m, Jun 1907 (fl), H. von Türckheim 11814 (HOLOTYPE: US!; ISOTYPES: C!, GH!, LL-TEX!, NY!, US!).

Ardisia meridensis Steyermark, Fieldiana, Bot. 28:454, fig. 95. 1953. TYPE: VENEZUELA. MÉRIDA: between Mucuchachi and Canagua, 1,065–1,820 m, 6 May 1944 (fl), J.A. Steyermark 56325 (HOLOTYPE: F!; ISOTYPES: F!, NY!, VEN, n.v.).

Gentlea tenuis Lundell, *Wrightia* 7:24. 1981. Syn. nov. *Ardisia jitotolana* Lundell,

Phytologia 61:65. 1986, non *Ardisia tenuis* Lundell, Wrightia 4:149. 1970. TYPE: MEXICO. CHIAPAS: Municipio de Rayón, in the Selva Negra 10 km above Rayón Meycalapa along road to Jitotol, 1,700 m, 12 Dec 1971 (fl), D.E. Breedlove 23144 (HOLOTYPE: F!; ISOTYPES: DS!, LL-TEX!, MO!, NY!).

Distribution and ecology.—Montane rain forests, evergreen cloud forests, premontane wet forests, 400–2,700 m. The most widely distributed species of the genus, *Gentlea venosissima* ranges from Oaxaca, Mexico southward through Mesoamerica to Venezuela, Colombia and Peru. It is expected, but has not as yet been collected, in Ecuador.

In many broadly ranging species of Myrsinaceae, most of the taxonomic overdescription for this species is attributable to the use of combinations of quantitative features to define taxa and differences in the expression of qualitative ones. Populations corresponding to the type of *Ardisia propinqua* Kunth are notable only for their slightly thinner leaves and less prominent punctations. The type of *Ardisia breviflora* is notable only for the slightly more persistent tomentum of the apical buds and more highly branched inflorescences. The type of *Ardisia robinsonii* represents populations from Colonia Tovar in Venezuela, with sepal apices slightly more acute, and petal punctations brown instead of black. The types of *Ardisia meiantha* and *Stylogyne phaenostemona* are notable only for their more sessile inflorescences and acuminate leaf apices. *Ardisia meridensis* is quantitatively and qualitatively identical to the type of *Gentlea venosissima*. Populations corresponding to the type of *Gentlea tenuis* are notable only in their very thin and inconspicuously punctate sepals and petals. Another common problem is that the species have been treated regionally, thus names are rarely compared over a range as large as Mesoamerica.

8. *Gentlea austinsmithii* (Lundell) Lundell, Wrightia 4:68. 1968. *Ardisia austinsmithii* Lundell, Contr. Univ. Michigan Herb. 7:36. 1942. TYPE: COSTA RICA. ALAJUELA: Region of Zarcero, Palmira, ca. 1,920 m, 9 Dec 1937 (fl), Austin Smith A673 (HOLOTYPE: MICH!; ISOTYPES: F!, MO!).

Gentlea molinae Lundell, Wrightia 4:150. 1970. Syn. nov. *Ardisia molinae* (Lundell) Lundell, Phytologia 61:65. 1986. TYPE: HONDURAS. LA PAZ: Montaña Verde on Cordillera Guajiquiro, 1,900 m, 23 Mar 1969 (fr), A. Molina R. & A.R. Molina 24389 (HOLOTYPE: LL-TEX!; ISOTYPES: F!, LL-TEX!, NY!).

Gentlea parviflora Lundell, Wrightia 5:89. 1975. Syn. nov. *Ardisia parvissima* Lundell, Phytologia 61:66. 1986, non *Ardisia parviflora* Talbot, Syst. list Trees, Bombay ed. 2, 204. 1902. TYPE: GUATEMALA. BAJA VERAPAZ: Union Barrios, in high forest, on top of hill, E of km 154, 11 Apr 1975 (fl), C.L. Lundell & E. Contreras 19212 (HOLOTYPE: LL-TEX!; ISOTYPES: CAS!, LL-TEX!).

Distribution and ecology.—*Gentlea austinsmithii* occurs in wet premontane, montane, elfin and cloud forests, and along watercourses in oak forests from Guatemala to Panama at 400–2,500 m elevation.

The type of *Gentlea molinae* Lundell, described in fruit, is notable only

for its slightly longer petioles and more prominent pitting on the abaxial surface. Populations represented by the type of *Gentlea parviflora* differ from the majority of populations of *G. austinsmithii* because of their more membranaceous leaves and slightly smaller flowers.

9. *Gentlea micranthera* (Donn.Sm.) Lundell, Wrightia 4:69. 1968. *Parathesis micranthera* Donn.Sm., Bot. Gaz. 18:205. 1893, non *Ardisia micranthera* Pitard in Lecomte, Fl. Gen. Indo-Chine 3:817. 1930. *Ardisia micrantha* Donn.Sm., Bot. Gaz. 14:27. 1889, nom. illeg., non *Ardisia micrantha* Kunth in H.B.K., Nov. Gen. Sp. 3:246. 1818. *Gentlea micrantha* (Donn.Sm.) Lundell, Wrightia 3:107. 1964, nom. illeg. *Ardisia staminosa* Lundell, Wrightia 3:78. 1963. TYPE: GUATEMALA. ALTA VERAPAZ: mountain forest near Coban, 4,600 ft [1,402 m], Mar, 1888 (fl), *H. von Türckheim* 1365 (HOLOTYPE: US!; ISOTYPES: F!, G!, GH!, LL-TEX!, NY!).

Gentlea mcvaughii (Lundell) Lundell, Wrightia 3:106. 1964. Syn. nov. *Ardisia mcvaughii* Lundell, Wrightia 3:77. 1963. TYPE: MEXICO. JALISCO: steep mountains 11–12 mi S of Talpa de Allende, in the headwaters of a west branch of Río de Talpa, barranca above a rapid clear stream, 1,200–1,700 m, 18–19 Oct 1960 (fl), *R. McVaugh* 20396 (HOLOTYPE: MICH!; ISOTYPE: LL-TEX!, MEXU!).

Gentlea cuneifolia Lundell, Wrightia 7:245. 1983. Syn. nov. *Ardisia cuneifolia* (Lundell) Lundell, Phytologia 61:63. 1986. TYPE: MEXICO. VERACRUZ: Municipio de San Andrés Tuxtla, cerca del aguaje en el lado S del Volcán San Martín Tuxtla, 1,250 m, 15 Feb 1972 (fr), *J.H. Beaman & C. Alvarez del Castillo* 5751 (HOLOTYPE: LL-TEX!; ISOTYPES: F!, MEXU!).

Gentlea auriculata Lundell, Phytologia 58:273. 1985. Syn. nov. *Ardisia parviauriculata* Lundell, Phytologia 61:66. 1986, non *Ardisia auriculata* Donn.Sm., Bot. Gaz. 24:395. 1897. TYPE: GUATEMALA. ZACAPA: Sierra de Las Minas, middle and upper south-facing slopes of Volcán Gemelos, 2,100–3,200 m, 26 Jan 1942 (fl, fr), *J.A. Steyermark* 43277 (HOLOTYPE: F!; ISOTYPES: LL-TEX!, US!).

Gentlea maculata Lundell, Phytologia 58:274. 1985. Syn. nov. *Ardisia morazanensis* Lundell, Phytologia 61:66. 1986, non *Ardisia maculata* Poit. ex A. DC., Trans. Linn. Soc., London 17:116. 1834. TYPE: HONDURAS. FRANCISCO MORAZAN: on mountain La Tigra, SW of San Juancito, 1,800–2,100 m, 02 Feb 1966 (fl), *A. Molina R., L.O. Williams, W.C. Burger & B. Wallenta* 16972 (HOLOTYPE: F!; ISOTYPES: NY!, US!).

Distribution and ecology.—Premontane, montane rain forests, evergreen cloud forests, primary forests, 900–3,300 m. A widely distributed species, from Jalisco, Veracruz and Chiapas, Mexico to Costa Rica.

The type of *Gentlea mcvaughii* represents populations with yellowish-green (instead of green) flowers and very short inflorescences. Populations corresponding to the type of *Gentlea cuneifolia* are notable only for their more cuneate leaf bases and inflorescence branches more densely glandular-puberulent. The type of *Gentlea maculata* is notable only for its slightly longer flowers.

EXCLUDED NAMES

***Ardisia mexicana* Lundell, Wrightia 3:77. 1963.** *Gentlea mexicana* (Lundell) Lundell, Wrightia 5:44. 1974. TYPE: MEXICO. JALISCO: crest of ridge facing the

Pacific, 10 mi S of Autlán, ca. 5,700 ft [1,737 m], 20 Aug 1949 (fl), *R.L. Wilbur & C.R. Wilbur 2460* (HOLOTYPE: LL!; ISOTYPE: MICH!).

This species is a member of *Ardisia* subgenus *Icacorea* (Aubl.) Mez, on account of its furfuraceous-lepidote leaves and ciliolate calyx margins. However, we have as yet to determine if this species has an earlier name in *Ardisia*.

Gentlea latisepala Lundell, *Wrightia* 5:4. 1972. TYPE: GUATEMALA. BAJA VERAPAZ: Chilasco, on Concepción Road, without elevation, 29 Jul 1971 (fr), *E. Contreras 10927* (HOLOTYPE: LL-TEX!).

This species belongs to *Ardisia* Subgenus *Icacorea* (Aubl.) Mez, and specifically, to the *Ardisia costaricensis* Lundell complex of species. However, in the absence of flowers, we have been unable to determine its exact systematic position.

Gentlea stevensii Lundell, *Wrightia* 6:97. 1979. *Ardisia stevensii* (Lundell) Lundell, *Phytologia* 61:67. 1986. TYPE: NICARAGUA. CHONTALES: ca. 2.8 km above (N of) Cuapa, 400–500 m, 21 Jan 1978 (fr), *W.D. Stevens 6053* (HOLOTYPE: LL-TEX!; ISOTYPE: MO!).

This species is a synonym of *Ardisia densiflora* Krug & Urban. Upon closer examination of the specimens, their sessile fruits and prominently rugose calyx lobes leave no doubt as to the true identity of this taxon.

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BOOK REVIEW

CLEBSCH, BETSY, drawings by CAROL D. BARNER. 1997. **A Book of Salvias—Sages for Every Garden.** (ISBN 0-88192-369-9, hbk.) Timber Press Inc., 133 S.W. Second Avenue, Suite 450, Portland, OR 97204-3527, (800) 327-5680, (503) 227-2878, Fax (503) 227-3070, <http://www.timber-press.com/> \$29.95. 269 pp, 87 color photos, 9 color paintings, 40 b&w line drawings done at 1.5 of actual size 6" × 9".

Betsy Clebsch is a noted amateur botanist and horticulturist in the San Francisco Bay area who has designed and maintained gardens in Virginia, Texas, and California. "*Gardening has been a thread pulled tight throughout my life, a steady interest that binds the pages that follow,*" says the author. She became intrigued with salvias when she began her second garden, a California country retreat. Unattended for several weeks at a time required the plants to be of resilient and drought tolerant stock, plants like many of the salvias. "*Writing about the culture of salvias would not have been possible had I not had a large garden in which to grow, observe, and enjoy the plants...and nursery people and botanists who visited the garden gave invaluable information as to a plant's source and who had grown it.*"

Wonderfully diverse in fragrance, bloom, habit and color, *Salvias* are the largest genus in the mint family, Lamiaceae. There are over 900 species worldwide and well over half occurring in the Americas with predictions by Ms. Clebsch of new and unusual salvias soon to be available in the US from the Far East (China, Japan and India).

Through twenty centuries salvias have been used and cultivated, but due to the large number of species and diverse native locations, botanists have been unable to treat them in a single work. From a horticulturist point of view, this book should be considered a fine start with lots of practical cultivation information.

For each of the 101 alphabetically listed salvias in the book, there is given: common and botanical name with Latin derivation, synonym (when a name change has caused confusion), cultivars and hybrids, native habitat, elevation range, temperature tolerance, and measurements (metric and imperial). Cultural practices are well defined including tips on pruning. Listed in the back are extremely helpful topics: Where to See Salvias (US, British Isles, France and Australia), Where to Buy Salvias, Flowering Guide by Season, Cold and Shade Tolerance Guides, Salvias with Especially Handsome Foliage, Salvias for Containers, Color Designations of Unusual Flower or Foliage Color, and Geographical Origin of Certain *Salvia* Species.

A Book of Salvias offers a wealth of information with lots of color photography and illustrations and new ideas for every gardener.—Linny Heagy.

NEW SPECIES OF *PSYCHOTRIA* SUBG.
HETEROPSYCHOTRIA (RUBIACEAE:
PSYCHOTRIEAE) FROM SOUTH AMERICA

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ABSTRACT

The new species *Psychotria cauligera*, *P. fusiformis*, *P. hypochlorina*, and *P. paeonia* are described and illustrated. These are all shrubs or small trees found in wet forests in Colombia, Venezuela, Ecuador, and Peru.

RESUMEN

Se describen e ilustran las especies nuevas *Psychotria cauligera*, *P. fusiformis*, *P. hypochlorina*, y *P. paeonia*. Todas son arbustos o arbolitos que crecen en bosques húmedos en Colombia, Venezuela, Ecuador y Perú.

Among recent collections from western South America, the following undescribed species of *Psychotria* L. Subg. *Heteropsychotria* Steyerl. were represented. The characteristics of this group, its relationships, and its recognition have been documented recently by Steyerl (1972, 1974) and Taylor (1994, 1996a, 1996b).

Psychotria cauligera C.M. Taylor, sp. nov. (Fig. 1A–D). TYPE: ECUADOR. PASTAZA: Veracruz, ca. 900 m, 18 Feb 1956, E. Asplund 19454 (HOLOTYPE: S).

Haec species a congeneris stipulis sat grandis ovatis vel ellipticis atque inflorescentiis (ut videtur caulogenis, vere terminalibus in ramulis vestustioribus) irregulariter ramosis, rhachidibus irregulariter flexuosis raceimformibus, floribus in glomerulos sessiles bracteis violaceis bene evolutis involucreto dispositis distinguitur.

Shrubs flowering at 0.25 m tall, to 2.5 m tall; stems quadrate becoming terete, glabrous or pilosulous to villosulous becoming glabrescent with age. *Leaves* paired; *blades* elliptic to obovate, 12–23 cm long, 8–13.5 cm wide, at apex acute to usually acuminate with tips to 1 cm long, at base acute to obtuse, drying papyraceous to chartaceous, adaxially glabrous, abaxially glabrous or hirtellous becoming glabrescent with age; secondary veins 16–20 pairs, spreading, broadly curved, extending to near margins or sometimes looping to interconnect in distal part of blade, with (0–)–1 weak intersecondary veins usually present between pairs of secondary veins, adaxially the costa and remaining venation plane, abaxially the costa prominulous to prominent, the secondary veins prominulous, and the mi-

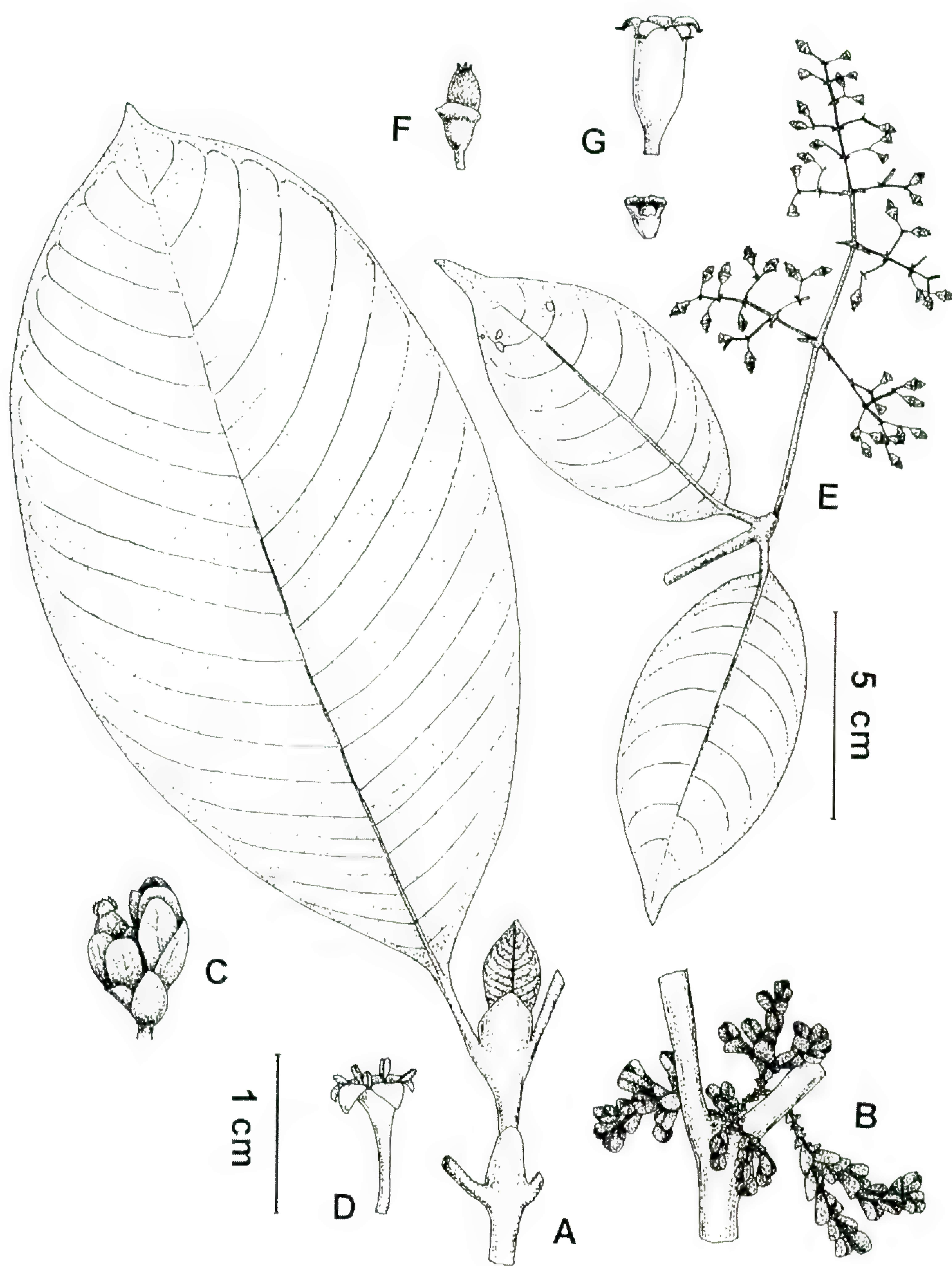


FIG. 1. A–D, *Psychotria cauligera* C.M. Taylor. A, Apex of leaf-bearing stem. B, Inflorescence borne on older stem. C, Fruiting glomerule, with fruit partially visible. D, Corolla. E–G, *Psychotria fusiformis* C.M. Taylor. E, Flowering branch. F, Flower bud. G, Flower at anthesis, partially dissected. A, B, E to 5-cm scale; C, D, F, G to 1-cm scale. A, B, based on Øllgaard 98491; C, D, based on Asplund 19454; E, F, G, based on Lugo 426.

nor venation plane to a little thickened; margins thinly to distinctly cartilaginous; *petioles* 1.5–5 cm long, glabrous or hirtellous becoming glabrescent with age; *stipules* glabrous or hirtellous becoming glabrescent with age, persistent at least with leaves, interpetiolar, ovate to elliptic, 12–30 mm long, obtuse to rounded, entire to ciliolate. *Inflorescences* terminal but overtopped by well developed stems from axils and appearing cauligerous, deflexed to pendulous, sessile or subsessile, corymbiform to rounded, 4–15 × 6–15 cm excluding corollas, with 3–6 pairs of developed secondary axes, with flowers sessile in glomerules of 3–7; bracts entire to ciliolate, elliptic to ovate, 4–6 mm long, glabrous to puberulous, obtuse to rounded or truncate, purple to lilac; *flowers* with *calyx* limb glabrous, ca. 1 mm long, divided nearly to base, lobes deltoid to ovate, acute to shortly acuminate, ciliolate; *corolla* tubular-funnelform, white, straight at base, externally glabrous, internally glabrous except for a sparsely pilose ring ca. 2/3 of length of tube above base, tube ca. 8 mm long, ca. 1 mm diam. near middle, lobes triangular, 2–2.5 mm long, acute, not thickened adaxially; *anthers* in short-styled form ca. 1.5 mm long, partially exerted; *stigmas* in short-styled form ca. 3.5 mm long and positioned near middle of tube; disk ca. 0.5 mm high, annular. *Infructescences* similar to inflorescences (plants frequently flowering and fruiting concurrently); *fruit* ellipsoid, ca. 5 × 2.5 mm, somewhat flattened laterally, glabrous to usually puberulous, blue; *pyrenes* with 3–5 low rounded longitudinal angles or ridges.

PARATYPES. ECUADOR. Morona-Santiago: Along narrow flood plain of Río Itzintza, Cordillera Cutucú, ca. 02°40'S, 78°W, *Camp 1222* (NY, S); ridge between Ríos Itzintza and Chupiasa, Cordillera Cutucú, ca. 02°40'S, 78°W, *Camp 1281* (NY, US); eastern slope and crest of main Cordillera Cutucú, *Jorgensen CuJ-376* (NY); Cordillera de Cutucú, 25 km SE of Logroño, *Madison & Coleman 2624* (NY); Cordillera de Cutucú, western slopes, along a trail from Logroño to Yaupi, in the general region, 02°46'S, 78°06'W, *Madison et al. 3320* (US). **Napo:** S slope of Cordillera de Guacamayos, new road Cotunda-Coca, 3–5 km from turn-off of Baeza-Archidona road, 01°52'S, 77°48'W, *Stein 3061* (MO). **Pastaza:** Puyo, ca. 2 km E of village, *Asplund 19313* (S); 3.5 km N of Puyo, *Fagerlind & Wibom 1074A* (S); Tentiente H. Ortiz, 18 km from Puyo on road to Tena, 01°23'S, 77°57'W, *Øllgaard & Balslev 9224* (AAU, MO, NY). **Zamora-Chinchipe:** Río Nangaritza, Colina Salada, ca. 2 km E of Destacamento Shaime, 04°22'S, 78°40'W, *Øllgaard 98491* (AAU). Cantón Nangaritza, Río Nangaritza, Shaime, 04°20'S, 78°40'W, *Palacios 6631* (MO, QCNE).

Distribution and Habitat.—In wet forest at 900–1,600 m, central to southern Ecuador. Collected in flower and fruit apparently usually concurrently, June, November, December.

This species is distinguished by its relatively large, ovate to elliptic stipules and inflorescences that appear cauligerous; these are terminal from older growth and irregularly branched, with the axes irregularly flexuous and racemiform; the flowers are borne in sessile glomerules and enclosed by

well developed red-purple bracts. The specific epithet refers to the position of the inflorescences. The inflorescences appear to be perennial, though field observations of this feature are lacking.

This species is placed in *Psychotria* rather than *Palicourea* based on its corollas that are straight at the base and pubescent internally only above the middle of the tube; within this group, it belongs to Subg. *Heteropsychotria*. However, *Psychotria cauligera* is overall most similar in general aspect to *Palicourea grandistipula* (Standl. ex Steyerf.) C.M. Taylor, which can be distinguished by its capitate or subcapitate inflorescences that are borne at young stem apices, with the leaves, and tubular corollas that are swollen at the base and pubescence just above this basal swelling.

Psychotria fusiformis C.M. Taylor, sp. nov. (Fig. 1E–G). TYPE: ECUADOR.

PASTAZA: Colonia 24 de Mayo, side road to road Puyo-Puerto Napo, ca. 18–20 km from Puyo, 13 Sep 1968, H. Lugo S. 426 (HOLOTYPE: MO-4278937; ISOTYPE: GB).

Haec species a congeneris floribus pedicellatis patentibus atque corollarum fusiformium lobulis appendices lineares gerentibus distinguitur.

Shrubs and trees flowering at 3 m tall, to 12 m tall; stems quadrate to terete, glabrous. *Leaves* paired; *blades* elliptic to elliptic-oblong, 5–14 cm long, 2–5.5 cm wide, at apex acuminate with tips 5–13 mm long, at base cuneate to obtuse, drying papyraceous, adaxially and abaxially glabrous; secondary veins 7–11 pairs, extending nearly to or sometimes uniting weakly with margins, with 1–3 pairs of intersecondary veins usually present between pairs of secondary veins, adaxially costa and secondary veins plane to a little thickened, abaxially costa prominulous and secondary veins plane or a little thickened; *petioles* 5–25 mm long, glabrous; *stipules* glabrous, interpetiolar and also sometimes shortly united intrapetiolarly, interpetiolar portion ovate, 4–5 mm long, bilobed for ca. 1/4 of their length, the lobes ligulate to somewhat elliptic, often overlapping laterally, obtuse to rounded, entire. *Inflorescences* terminal, apparently deflexed, with peduncles 3–10.5 cm long; panicles pyramidal, 5–12 x 5–12 cm, with 5–8 pairs of developed secondary axes, with flowers pedicellate in dichasial cymules of 2–3 or solitary; bracts glabrous, triangular, acute, ciliolate, green, those subtending secondary axes 2–6 mm long, those subtending flowers 0.8–1 mm long; pedicels in terminal flowers of cymules and solitary flowers ca. 0.5 mm long, pedicels in lateral flowers of cymules 3–5 mm long; *flowers* with hypanthium obconic, 1–1.2 mm long, glabrous; *calyx* limb 0.5–1 mm long, glabrous, truncate to sinuate; *corolla* in bud tubular to somewhat fusiform and externally densely puberulous to shortly, stoutly papillose-pubescent, at anthesis infundibuliform, yellow, externally sparsely pubescent to glabrescent, internally glabrous, tube ca. 8 mm long, ca. 1 mm diam. at base and ca. 3 mm diam. at middle, lobes 5, triangular, 1.5–2 mm long, at apex

acute with a linear, glabrous appendage 0.2–0.5 mm long; *anthers* ca. 2 mm long, positioned ca. 2/3 of length of tube above base; *style* and *stigma* not seen; disk 0.3–0.5 mm high, smooth, annular. *Infructescences* and *fruits* not seen.

PARATYPES. ECUADOR. Morona-Santiago: Puerto Santana, ca. 5–6 km from Shell-Mera, *H. Lugo S.* 448 (GB, MO). Napo: 9 km río abajo de Puerto Misahualli y 2 km al S de la cuenca del Río Chinguipino, 01°05'S, 77°36'W, *Neill et al.* 6053 (MO). Pastaza: road Puyo-Macas (under construction), 31 km from Puyo, 01°37'S, 77°50'W, Øllgaard & Balslev 9044 (AAU, F, US).

Distribution and Habitat.—Wet forest at 430–1,100 m, east-central Ecuador; collected in flower March, August, September.

This new species is distinguished by its interpetiolar stipules that are shortly bilobed with the lobes rounded to obtuse, spreading pedicellate flowers, and corollas that are densely puberulous to stoutly papillose-pubescent externally in bud and bear a short linear appendage at the apex of each lobe. The specific epithet refers to the distinctive shape of the corolla in bud. It belongs to Subg. *Heteropsychotria*; vegetatively and in many details of the flowers, this species is similar and probably related to *Psychotria caerulea* Ruiz & Pav. and *P. nautensis* Standley, both of which differ from *P. fusiforme* in having sessile flowers that are partially enclosed by their larger floral bracts.

Psychotria hypochlorina C.M. Taylor, sp. nov. (Fig. 2A–B). TYPE: PERU. LORETO: Prov. Maynas, Saboya, Río Pintuyacu, 03°50'S, 74°10'W, 150 m, 19 Apr 1986, R. Vásquez, N. Arévalo, & N. Jaramillo 7420 (HOLOTYPE: MO-5079650; ISOTYPE: GB).

Haec species a *Psychotria costanensis* Steyerm. et *P. cuatrecasasii* (Standley ex Steyerm.) C.M. Taylor inflorescentia subcapitata vel breviter semel-ramosa atque foliorum venatione minore abaxialiter invisibili distinguitur.

Shrubs and trees flowering at 3 m tall, to 8 m tall; stems quadrate becoming terete, glabrous. *Leaves* paired; *blades* elliptic to elliptic-oblong, 8–30 cm long, 2.8–14 cm wide, at apex acute to usually acuminate with tips 8–12 mm long, at base acute to cuneate or obtuse, drying chartaceous, adaxially and abaxially glabrous, when dry discolorous, adaxially dark, abaxially paler and yellowed; secondary veins 11–14 pairs, extending nearly to margins and then reticulating extensively, with 1–3 intersecondary veins present between pairs of secondary veins, adaxially venation plane or costa a little thickened proximally, abaxially costa prominulous and remaining venation plane or a little thickened; *petioles* 1–5.5 cm long, glabrous; *stipules* glabrous, interpetiolar and also shortly united intrapetiolarly, interpetiolar portion bilobed, between the lobes truncate to a little concave, 3–4 mm long, lobes triangular to narrowly so, 1–2 mm long, acute, entire. *Inflorescences* terminal, apparently erect, glabrous, subcapitate or branched once, with

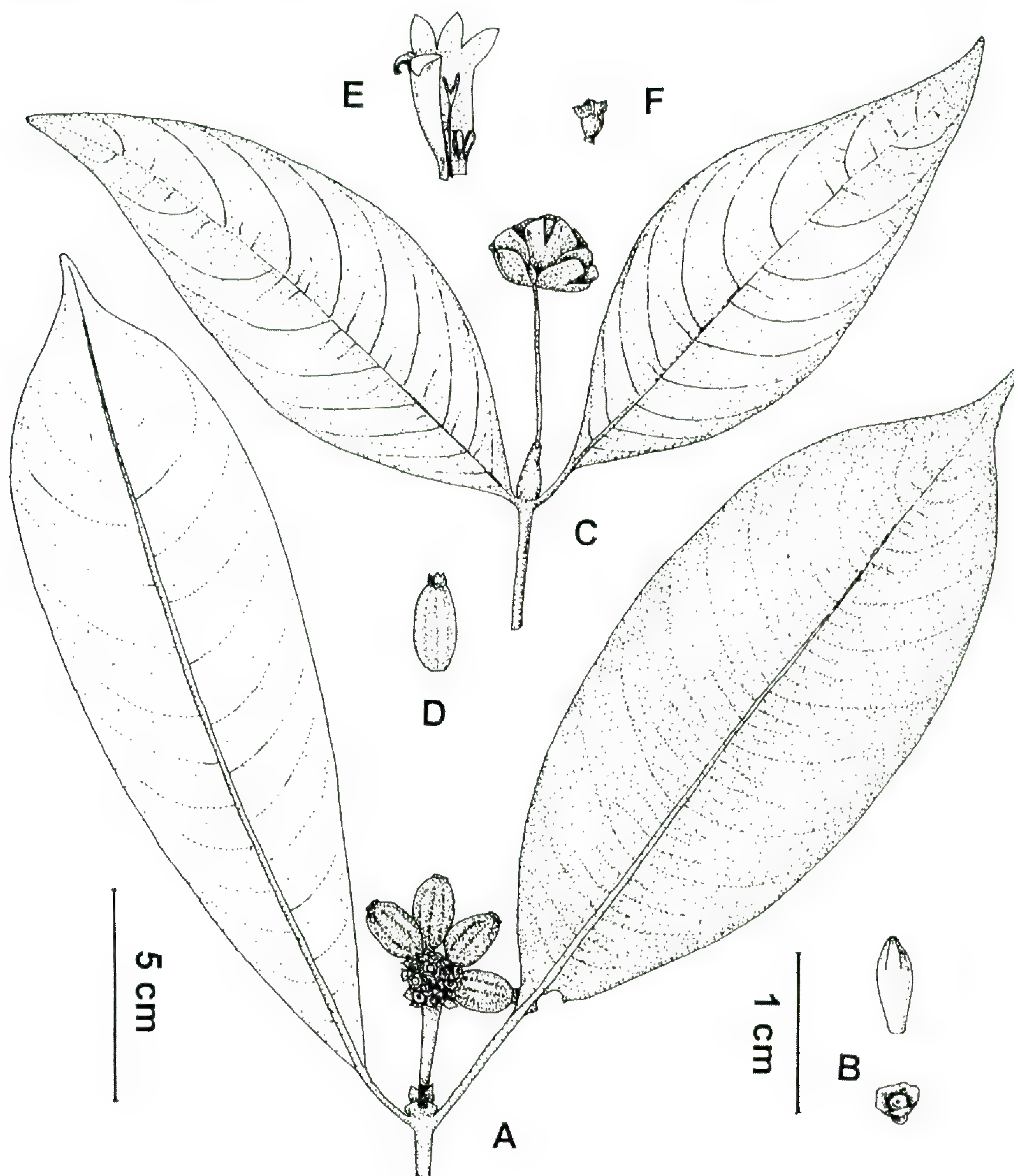


FIG. 2. A–B, *Psychotria hypochlorina* C.M. Taylor. A, Flowering branch. B, Flower bud, partially dissected. C–F, *Psychotria paeonia* C.M. Taylor. C, Flowering branch. D, Fruit. E, Corolla, partially dissected. F, Calyx limb and hypanthium. A, C, to 5-cm scale; B, D, E, F, to 1-cm scale. A, B, based on *Croat* 20513; C, based on *Harling & Ståhl* 26747; D, based on *Schunke* 5796; E, F, based on *Smith* 2438.

peduncles 1.2–5.5 cm long and stout, heads or panicles hemispherical to pyramidal, 1–2 x 1–3 cm excluding fruits, unbranched or sometimes with 1 pair of developed, stout secondary axes, with flowers sessile in glomerules of ca. 5–15; bracts glabrous, triangular to ovate, acute to acuminate, ciliolate,

apparently green, those subtending secondary axes and glomerules 5–8 mm long, those subtending flowers 3–5 mm long; *flowers* with hypanthium obconic, ca. 1 mm long, glabrous; *calyx* limb 1–1.2 mm long, glabrous, truncate or sometimes 5-denticulate; *corolla* in bud infundibuliform, greenish white to lilac, externally glabrous, lobes 5, triangular. *Infructescences* similar to inflorescences or with axes expanded; *fruits* ellipsoid, 15–16 x 10–11 mm, glabrous, becoming yellow-orange or orange then red then black, crowned by the persistent calyx; pyrenes 2, with 4–5 longitudinal ridges.

PARATYPES. PERU. Loreto. Prov. Maynas: Río Napo at Entrada de Isla Inayuga, *Croat* 20513 (MO); via Nauta-Iquitos, 3 km de Nauta, 04°30'S, 73°32'W, *Díaz & Jaramillo* 1260 (MO); Río Nanay, Caserio Mishana, 30 km SW of Iquitos, *Foster* 4230 (MO), 4368 (MO, NY); Mishana, Río Nanay halfway between Iquitos and Santa María de Nanay, near Campamento 1, *Gentry et al.* 36508 (MO); carretera Nauta-Iquitos, Km 4.5, 04°29'S, 73°35'W, *Grández & Ruíz* 2149 (MO); Mishana, 03°55'S, 73°35'W, *Vásquez & Criollo* 1775 (MO), *Vásquez et al.* 5340 (MO). Prov. Requena: without locality, *Pereira et al.* 106 (MO); distrito Sapuena, Poblado Jenaro Herrera, CIJH-IIAP, *Acevedo & Daly* 1602 (NY); Jenaro Herrera, Río Ucayali, 73°45'W, 04°55'S, *Gentry et al.* 56277 (MO); north vicinity of Requena, Chacra Canamá, east side of river, *Mathias & Taylor* 5540 (MO); Requena, Chacra Canamá, *J. Schunke Vigo* 6248 (MO); south of Requena, *J. Schunke Vigo* 6253 (MO); alrededores de Requena, 05°05'S, 73°50'W, *Vásquez & Jaramillo* 4729 (MO). Prov. Ucayali: Canchahuayo (Río Ucayali), 07°05'S, 75°10'W, *Vásquez et al.* 6967A (MO).

Distribution and Habitat.—Wet forest at 125–500 mm, northeastern to east-central Peru, frequently on sandy soils; collected in flower November, in fruit February–September and November–December.

This new species is distinguished by its leaves with the lower (abaxial) surface drying markedly paler than the upper (adaxial) surface and the venation hardly visible, subcapitate to shortly branched inflorescences, truncate relatively well developed calyx limb, and relatively large fruits. The specific epithet refers to the unusual drying color of the abaxial leaf surface, which is distinctive and is also found in a few other, apparently related species of *Psychotria* Subg. *Heteropsychotria*. These species also share similar leaf venation characters, inflorescence morphology, and relatively large fruits. Steyermark treated the species of this group from northeastern South America in Section *Pseudocephaelis* Steyermark., Series *Appunianae* Steyermark. These have been frequently confused, but can be separated according to the key below.

KEY TO THE SPECIES OF PSYCHOTRIA SUBG. HETEROPSYCHOTRIA

SECT. PSEUDOCEPHAELIS, SERIES APPUNIANAE

1. Inflorescences umbelliform, with secondary axes 3–5, all produced from first node and equal in length to primary axis *P. conephoroides* (Rusby) C.M. Taylor
1. Inflorescences capitate or pyramidal, with secondary axes 1–2 pairs and shorter than the primary axis, so the structure is pyramidal.

- 2. Stipules 11–15 mm long, with lobes 1/2 or more of this length
..... **P. tepuiensis** (Steierm.) Steierm.
- 2. Stipules 3–8 mm long, with lobes less than 1/2 this length.
- 3. Inflorescences with secondary axes clearly developed, the primary axis with at least one internode > 1 cm long.
 - 1. Reticulate minor venation evident on lower (abaxial) leaf surface
..... **P. transiens** Wernham
 - 4. Secondary and intersecondary veins evident on lower (abaxial) leaf surface but reticulate minor venation not visible.
 - 5. Leaves with usually 1 intersecondary vein present between pairs of secondary veins; growing at 100–1,200 m
..... **P. cordobensis** C.M. Taylor
 - 5. Leaves with 1 or 3 intersecondary veins present between pairs of secondary veins; growing at 1,500–2,050 m
..... **P. jervisei** (Standley) C.M. Taylor
- 3. Inflorescences capitate or with secondary axes developed, the primary axis with internodes all < 1 cm long.
 - 6. Inflorescences subcapitate to once branched, with bracts subtending secondary axes or outermost bracts of head triangular to ovate, acute, 5–8 mm long; peduncles 1.2–5.5 cm long; leaves with reticulate minor venation not evident on lower surface
..... **P. hypochlorina** C.M. Taylor
 - 6. Inflorescences capitate, unbranched, with outermost bracts ovate to suborbicular or oblong, acute to obtuse to rounded, 5–14 mm long; leaves with reticulate minor venation evident on lower surface.
 - 7. Involucral bracts 5–8 mm long; peduncle 2.5–9 cm long; stipules 3–4 mm long; notheastern to central South America
..... **P. costanensis** Steierm.
 - 7. Involucral bracts 10–14 mm long; peduncles 1–5 cm long; stipules 5–10 mm long; western South America
..... **P. cuatrecasasii** (Standl. ex Steierm.) C.M. Taylor
(perhaps not distinct from *P. costanensis*, see Taylor 1994)

Psychotria paeonia C.M. Taylor, sp. nov. (Fig. 2C–F). TYPE: PERU. AMAZONAS: alrededor de Yucui Entsa, 6 horas de Pongo por el Camino de Kusu, 1,200–2,000 m, 11 Mar 1973, *R. Kayap* 550 (HOLOTYPE: MO-5079651; ISOTYPE: GB).

Haec species a *Psychotria adenophora* Steierm. stipulis 8–15 mm longis atque inflorescentiae bracteis externis 10–15 mm longis distinguitur.

Shrubs and subshrubs flowering at 0.7 m tall, to 2.5 m tall; stems quadrate becoming terete, glabrous. *Leaves* paired; *blades* elliptic to somewhat lanceolate, 11–19 cm long, 3.5–8 cm wide, at apex acute to slightly acuminate, at base acute to cuneate, drying papyraceous, adaxially glabrous, abaxially puberulous and green or purple; secondary veins 9–12 pairs, extending nearly to margins and often uniting into a looping submarginal vein, with 1–3 weak intersecondary veins usually present between pairs of secondary veins, adaxially costa and secondary veins plane to thickened, abaxially costa prominulous and secondary veins a little thickened to

prominulous; *petioles* 5–15 mm long, glabrous; *stipules* glabrous, interpetiolar, lanceolate to ovate, 10–15 mm long, bilobed for ca. 1/8–1/4 of their length, the lobes triangular, acute, entire. *Inflorescences* terminal, perhaps deflexed, capitate to subcapitate, with peduncles 3–8.5 cm long, heads hemispherical to oblate, $1\text{--}2.5 \times 2\text{--}3.5$ cm, with flowers sessile in glomerules of 5–15; bracts glabrous, obtuse to rounded, entire, green becoming purple, those enclosing the inflorescence elliptic to suborbicular, 10–15 mm long, those subtending flowers elliptic to narrowly so or obovate to oblanceolate, 6–10 mm long; *flowers* with hypanthium obconic, ca. 1 mm long, glabrous; *calyx* limb glabrous, 0.8–1 mm long, lobed to base, lobes oblong to elliptic, obtuse to rounded; *corolla* funnelform, straight to a little swollen at base, straight to a little constricted near middle, and then spreading, white, externally glabrous, internally glabrous except for a zone of sparse pubescence from near middle to the base of the anthers, tube 7–8 mm long, 1–1.5 mm in diameter near base and 3–4 mm in diameter at mouth, lobes 5, 1.5–2 mm long, triangular; *anthers* in apparent long-styled form 1.5–2 mm long, positioned at or just below middle of tube; *stigmas* in apparent long-styled form linear, ca. 1 mm long, positioned at mouth of corolla tube; disk annular, ca. 0.5 mm high. *Infructescences* similar to inflorescence or becoming a little more expanded, with bracts purple; *fruit* ellipsoid, $5 \times 2.5\text{--}3$ mm, purple; pyrenes 2, with 3–5 low, rounded, longitudinal ridges.

PARATYPES. **COLOMBIA.** Amazonas-Vaupés: Río Apaporis, Cachivera de Jirijirimo y alrededores, *Schultes & Cabrera* 12898 (COL). Antioquia: Municipio de San Carlos, Corregimiento Alto de Samaná, Vereda Miraflores, *Fonnegra et al.* 3039 (HUA, MO); Municipio de Amalfi, Vereda Peldar, Mina La Viborita, 06°55'N, 75°04'W, *Fonnegra et al.* 4516 (HUA, MO). **ECUADOR.** Morona-Santiago: 6 km E of Limón on road (under construction) to La Unión, *Harling & Andersson* 24481 (GB); end of road in construction Limón-La Unión, ca. 10 km from Limón, *Harling & Ståhl* 26722 (GB), 26747 (GB, S); Shuinia Nait, ca. 8 km SE of Misión Bomboiza, 03°30'S, 78°33'W, *Holm-Nielsen et al.* 4381 (AAU, S), 4382 (AAU, MO, S); about 1/2 hour by car along unfinished road E of El Limón, *van der Werff & Palacios* 10425 (MO). Zamora-Chinchipe: El Pangui Cantón, along road between Zamora and Gualaquiza, 70.9 km N of bridge over Río Zamora in Zamora, between Los Encuentros and El Pangui, 03°42'S, 78°25'S, *Croat* 72733 (MO); 3 km E Paquisha, *Harling & Andersson* 23964 (GB); Nangaritza Cantón. Pachicutza, camino al Hito, Cordillera del Cóndor, 04°07'S, 78°37'S, *Palacios et al.* 8321 (MO), 8372 (MO); hill about 2 km downstream from Campamento Shaime along Río Nangaritza, *van der Werff et al.* 13055 (MO). **PERU.** Amazonas. Prov. Condorcanqui: near Yuwi Inci Creek, 6 hours' walk from the Pongo Mori, Río Comaina, *Berlin* 958 (MO); Quebrada de Basusinuk, tributary of Huampami, *Kayap* 90 (MO); distrito El Cenepa, Región Nororiental del Marañón, Río Cenepa, comunidad Tutino, 04°33'S, 78°10'S, *Vásquez et al.* 18519 (MO), 18544 (MO). Cuzco. Prov. Paucartambo: Cosnipata Valley, Río Tono First, on road N of Patria, 13°07'S, 71°12'W, *Wachter et al.* 217 (F, MO). Huánuco. Prov. Leoncio Prado: E of Tingo María, *J. Schunke Vigo* 5796 (MO); distrito Rupa Rupa, E de Tingo María, cerca al Cerro Quemado, *J. Schunke Vigo* 9951 (MO). Pasco. Prov. Oxapampa: Pichis Valley, San Matias Ridges, 10–12 km SW of Puerto Bermúdez, above Santa Rosa de Chivis, trail to

Loma Linda, 10°20'S, 75°00'S, *Foster et al.* 8987 (MO); W of Cordillera San Matias above Santa Rosa de Chivis, *D. N. Smith et al.* 2438 (MO). VENEZUELA. Mérida: Distrito Tovar, La Llorona, on road to Amparo, 08°22'N, 72°45'W, *van der Werff & Ortíz* 5752 (MO).

Distribution and Habitat.—Wet forest at 250–2,000 m, south-central Peru (Cuzco) to northwestern Colombia (Antioquia) and western Venezuela (Mérida); collected in flower February–April, September, November, and December, in fruit February, April, June, July, October, and November.

This species is distinguished by its lanceolate to ovate, interpetiolar stipules that are 10–15 mm long and shortly bilobed, capitate to subcapitate inflorescences with obtuse to rounded bracts that are green when the flowers start blooming and become purple as the fruits develop, funnelform white corollas with tubes 7–8 mm long, and rather narrow fruits. The specific epithet refers to the general aspect of the inflorescences and infructescences, which are reminiscent of flowers of *Paeonia* (Ranunculaceae).

Within Subg. *Heteropsychotria*, this new species is similar to *Psychotria adenophora* Steyerem. and *P. ostreophora* (Standley) C.M. Taylor (syn., *P. lucentifolia* (Blake) Steyerem.): both of these latter species can be distinguished by their stipules with truncate sheaths 0.5–1 mm long and slender lobes 0.5–12 mm long.

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THE VEGETATION OF CUCPHUONG NATIONAL PARK, VIETNAM

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ABSTRACT

Cucphuong National Park, situated about 120 km south from Hanoi, northern Vietnam, is the first National Park of Vietnam. It occupies approximately 22,220 hectares. The flora is rich containing 1,924 species in 990 genera and 229 families. It is characterised by the following: Fabaceae, Euphorbiaceae, Rubiaceae, Asteraceae, Lauraceae, Moraceae, Anacardiaceae, Combretaceae and Juglandaceae. The dominant genera of the flora are of *Shorea*, *Terminalia*, *Dracontomelum*, *Cinnamomum*, *Hirtiera*, *Anamocarya*, *Tetrameles*. The life-forms of the flora are diverse and shown the following: SB = 60.44 Ph + 9.77 Ch + 11.57 H + 7.82 Cr. + 10.29 Th, in which Ph = 13.37 MM + 13.32 Mi + 10.08 Na + 11.42 Lp + 11.37 Ep + 0.67 Pp + 0.33 Hp.

RESUMEN

El Parque Nacional de Cucphuong, situado unos 120 km al sur de Hanoi, Vietnam del Norte, es el primer Parque Nacional de Vietnam. Ocupa aproximadamente 22,220 hectáreas. La flora es rica, ya que contiene 1,924 especies pertenecientes a 990 géneros y 229 familias. Se caracteriza por las siguientes: Fabaceae, Euphorbiaceae, Rubiaceae, Asteraceae, Lauraceae, Moraceae, Anacardiaceae, Combretaceae y Juglandaceae. Los géneros dominantes de la flora son *Shorea*, *Terminalia*, *Dracontomelum*, *Cinnamomum*, *Hirtiera*, *Anamocarya*, *Tetrameles*. Las formas vitales de la flora son diversas y muestran lo siguiente: SB = 60.44 Ph + 9.77 Ch + 11.57 H + 7.82 Cr. + 10.29 Th, donde Ph = 13.37 MM + 13.32 Mi + 10.08 Na + 11.42 Lp + 11.37 Ep + 0.67 Pp + 0.33 Hp.

INTRODUCTION

Cucphuong is situated about 120 km south of Hanoi on the boundary intersection of three provinces Hoabinh, Ninhbinh and Thanhhoa, with longitudes from 105°24'E to 105°44'E and latitudes from 20°14'N to 20°24'N (Fig. 1). It was classified for the first time as a primary forest area in 1960 and declared the first National Park of Vietnam in 1962 by the Vietnam Government. It occupies approximately 22,220 hectares and includes a part of a limestone belt running from northwest Vietnam to the seashore in Ninhbinh Province. Geographical and topographical conditions are complex and thus the flora and fauna are also of great diversity.

Topography

Cucphuong is situated on karst limestone mountains with many caves,



FIG. 1. Cucphuong National Park.

including Hang Dang or Dong Nguoi Xua (the cave of Primitive man) in which human archeological remains dated to 7,000 years ago have been found. In some caves, the mountains serve as natural walls to protect its diverse flora and fauna. The highest point is 650 m.

One large valley is oriented in a northwest-southeast direction. Many other small valleys, separated from one another, contain many interesting features of natural history.

Climate

Cucphuong has a monsoon, tropical climate with an average annual temperature during the year of 24.7°C, with a minimum 16.6°C, and a maximum 39°C. The average rainfall is 2,157 mm, with an average humidity of 90%.

Soil

The Cucphuong soil is derived from limestone, with schist, argillite and quartz. There are different kinds of soil varying from the foot to the top of the limestone mountains including Rensin red greiss-yellow, red-yellow, black, margaliste-ferralite yellow. On the non-limestone mountains, there are several types of soil, such as ferralite yellow and ferralite yellow-red. In general, the soil of Cucphuong is of a light texture, and is generally moist because of its rather favourable character of imbibition.

Streams and water regimes

Song Buoi River is the only river passing through the northwest part of Cucphuong, and many streamlets occur in the summer. The streamlets dry up in the winter due to the shortage of rainfall in Cucphuong.

DIVERSITY OF FLORA

On the basis of collected specimens—which are deposited in the Cucphuong herbarium (CP) and on the basis of local floras (Anonymous 1971; Aubreville 1960–1994; Do Tat Loi 1991, Chan et al. 1995; Lecomte 1907–1951; Thin 1987, 1992; Pocs 1965; Trung 1978; Vu Nguyen 1987)—1,924 species in 990 genera and 229 families of higher plants have been identified and arranged according to Takhtajan's system (Takhtajan 1966, 1969). The major groups (7 divisions) are listed in Table 1.

All representatives of higher plant divisions are present in the Cucphuong forest. As expected, the most diverse and profuse division is Angiospermae. Gymnospermae are poorly represented with three species; *Podocarpus fleuryi* (Podocarpaceae) is a relict of the Tertiary era. Its pollen record shows that it grew in this area in the Tertiary period (Colani 1920; Trinh Danh 1985, 1986). It is fairly common on the slopes of the limestone hills. Equisetophyta is represented only by one species of *Equisetum*. Bryophyta have been well studied is the most complete for any park in Vietnam, with 125 species in 70 genera of 31 families (Pocs 1965b). This group also shows the relatively primary character of the forest area. Polypodiophyta is rather diverse, with 127 species in 56 genera of 27 families. Some relict genera are also present here such as *Cyathea* (Fig. 2), *Angiopteris*, *Archangiopteris* and *Cibotium*. Table 2 lists the most common genera and the number of species for the Cucphuong flora.

The Angiospermae is the most diverse, especially the class Dicotyledones (Table 1). The numbers of species in selected families are noted: Fabaceae (107 sp.), Euphorbiaceae (101), Rubiaceae (78), Asteraceae (64), Lauraceae (54), with Moraceae, Anacardiaceae, Combretaceae, and Juglandaceae, following. Some families have a small number of species but may be quite dominant, such as Sterculiaceae, and Dipterocarpaceae. Species of *Heritiera* (Sterculiaceae) are seen everywhere in the forest, the leaves often conspicuous with silver white undersides. In the Dipterocarpaceae, *Shorea chinensis* is common. These trees have straight unbranched trunks to 65 m high and 1.5 m diameter. *Terminalia myriocarpa* (Combretaceae) (Fig. 3) has trunks to 45 m high and 5.5 m diameter. *Tetrameles nudiflora* (Datiscaceae) (Fig. 4) has a straight trunks, 45 m high and 5.5 m diameter. *Cinnamomum balansae* (Lauraceae, called “Vu huong”) has trunks of fragrant wood, 48 m high and 2.5 m diameter. *Dracontomelum duperreanum* (Anacardiaceae) is well-known for its huge buttresses.

TABLE 1. The flora of the Cucphuong National Park is diverse, for a small area with about 0.7% of the total for Vietnam, yet the number of plant species reaches almost 25% of the total species reported for the country.

Taxon	Number		
	Species	Genera	Families
Bryophyta	125	70	31
Psilotophyta	1	1	1
Lycopodiophyta	9	2	2
Equisetophyta	1	1	1
Polypodiophyta	127	56	27
Gymnospermae	3	3	3
Angiospermae			
Dicotyledones	1,281	674	134
Monocotyledones	377	183	30

There are many lianas growing upwards by attaching themselves to the forest trees including *Gnetum* sp. (Gnetaceae). Of the Angiospermae, there are lianas in Sterculiaceae (2 sp.), Fabaceae (3 sp.), and Apocynaceae (1 sp.). *Entada phaseoides* (Fabaceae) with stems 10–20 m long and 20–25 cm in diameter (Fig. 5), *Bauhinia scandens* with stems 10 m long and 10–15 cm in diameter, and *Acacia pennata* (Fabaceae) are very common. There are seven species of *Ficus* (Moraceae), some of *Schefflera* (Araliaceae), and *Fagraea* (Loganiaceae) strangling and twining around neighbouring trees (Table 3), that start life as epiphytes and whose roots grow down, interlacing around their support. Eventually the host dies as it is shaded out, leaving the strangler supporting itself.

Various species of shade-loving epiphytes include *Psilotum nudum*, *Lycopodium carinatum*, *Mecodium exsertum*, *Lomariopsis spectabilis*, *Lemmaphyllum microphyllum* var. *obovatum*, *Leptochilus laciniatus* var. *simplex*, *Loxogramme lankokiensis*, *Vittaria* (7 spp.), *Ficus pumila* and *Aglaonema* sp.

Light-loving epiphytes on branches of high trees include such orchids as *Aerides odoratum*, *Cirrhopetalum siamense*, *Cymbidium aloifolium*, *Dendrobium* spp., *Luisia teretifolia*, *Oberonia*, *Rhynchostylis gigantea*, *Sarcanthus* spp., *Thrixspermum centipeda*, and *Vanda* species. Also, there are *Anadendron latifolium*, *Pothos* spp., and *Rhaphidophora* spp. (Araceae); and *Drynaria fortunei* (Polypodiaceae), as well as many species of lichens and mosses.

At ground level very few plants occur except those which obtain nutrients from decaying plant matter such as *Balanophora* (Balanophoraceae) (3 sp.) and other parasitic species living on the roots of other plants.

Some others are semiparasitic living on the branches of other plants as *Viscum* (Viscaceae) living on *Liquidambar formosana*; *Viscum* and *Loranthus* spp. (Loranthaceae), and on other plants such as *Averrhoa carambola*, *Ficus* sp., and *Citrus* spp. A great number of species with lovely flowers and leaf



FIG. 2. *Cyathea contaminans* (Cyatheaceae).

shapes are *Paris chinensis*, *P. hainanensis* (Trilliaceae) (Fig. 6), *Amorphophallus paeonifolia* (Fig. 7), *A. rivieri*, *A. tonkinensis*, *Arisaema balansae* (Araceae), *Angiopteris repandula* (Marattiaceae), *Milletia ichthyochtona*, *Saraca dives* (Fabaceae), *Firmiana colorata* (Sterculiaceae), *Aerides odoratum*, *Dendrobium lindleyi*, *D. superbum*, *Vanda teres*, *Paphiopedilum appletonianum*, *P. delenatii*, *Haemaria discolor* (Orchidaceae), *Tacca chantrieri* (Taccaceae). Some plants are cauliflorous such as *Baccaurea ramiflora*, *Meliantha suavis*, *Ficus* spp., and *Dimerocarpus brennieri*.

STRUCTURE OF FLORA

The Cucphuong flora is characterized by the stamps of the tertiary era flora of North Vietnam and South China (Trung 1978). It includes

TABLE 2. The most common genera with number of species for the Cucphuong National Park.

Genus	Spp.	Genus	Spp.
Pteridophytes		<i>Blumea</i>	9
<i>Selaginella</i>	7	<i>Callicarpa</i>	9
<i>Tectaria</i>	7	<i>Justicia</i>	9
<i>Colysis</i>	8	<i>Mallotus</i>	9
<i>Lygodium</i>	8	<i>Antidesma</i>	10
<i>Asplenium</i>	9	<i>Carex</i>	10
<i>Pteris</i>	9	<i>Clerodendrum</i>	10
<i>Cyclosorus</i>	10	<i>Beilschmiedia</i>	11
Spermatophytes		<i>Dendrobium</i>	11
<i>Croton</i>	8	<i>Litsea</i>	12
<i>Eragrostis</i>	8	<i>Polygonum</i>	12
<i>Phyllanthus</i>	8	<i>Cyperus</i>	13
<i>Schefflera</i>	8	<i>Desmodium</i>	13
<i>Callicarpa</i>	8	<i>Syzygium</i>	14
<i>Cinnamomum</i>	9	<i>Ardisia</i>	15
<i>Fimbristylis</i>	9	<i>Ficus</i>	38

many species of Fagaceae, Fabaceae, Lauraceae, Juglandaceae, Altingiaceae, Ebenaceae, Annonaceae, Sterculaceae, Meliaceae, Sapindaceae, Magnoliaceae, and Anacardiaceae, and most species of Gymnospermae. Fossil evidence also affirms that earlier plants similar to the present species, such as *Cinnamomum balansae*, *Heritiera macrophylla*, *Celtis sinensis*, *Liquidambar formosana*, *Saraca dives*, and *Amoora gigantea* occurred in this area (Colani 1920; Trinh 1985, 1986).

Cucphuong is a place where many different floras overlap (Pocs 1965a, 1965b) because it is the meeting point of mountain ranges from the Himalaya running northwest-southeast, from South China running north-south, and from South Vietnam running north-south.

The flora Malesiana elements are characterized by species linked to a hot and humid climate derived from Borneo (Trung 1978). These elements entered Vietnam in the Tertiary Era (Trung 1978, Danh 1986) and include species of Dipterocarpaceae. Although the number of species is low, the number of individuals is relatively great.

The Himalayan element of the flora is characterised by temperate species from Yunnan, Quichau and Himalaya including numbers of Fagaceae, Aceraceae, Oleaceae, Ulmaceae, Hippocastanaceae, Trilliaceae, and Juglandaceae.

The Indo-Burmese element of the flora is characterised by deciduous species like *Terminalia myriocarpa*, *Combretum* spp., *Anogeissus acuminata* (Combretaceae), *Lagerstroemia corniculata* (Lythraceae), *Bombax malabaricum* (Bombacaceae), *Tetrameles nudiflora* (Datiscaceae), and *Sapindus saponaria* (Sapindaceae).



FIG. 3. *Terminalia myriocarpa* (Combretaceae) with trunks to 45 m high and 5.5 m in diameter.



FIG. 4. *Tetrameles nudiflora* (Datiscaceae) with straight trunks, 45 m high and 5.5m in diameter.



FIG. 5. *Entada phaseoides* (Fabaceae) with stems 10–20 m long and 20–25 cm in diameter.

TABLE 3. Lianas and strangling epiphytes of the Cucphuong forest.

<i>Ficus annulata</i>	<i>Ficus pilosa</i>
<i>Ficus benjamina</i>	<i>Ficus religiosa</i>
<i>Ficus glaberrima</i>	<i>Ficus retusa</i>
<i>Ficus gibbosa</i>	<i>Schefflera glomerulata</i>
<i>Ficus lacor</i>	<i>Fagraea obovata</i>
<i>Ficus obtusifolia</i>	

DISTRIBUTION OF THE CUCPHUONG FLORA

Plant groups are divided on the basis of types of the topography and the soil.

Plants on the summits of limestone mountains

On summits from 300–560 m altitude with sharp hard rocks and with black renzin soil, the humidity is low and the evaporation rate is high. The diversity of plants include 65 common species such as *Cycas balansae*, *Cinnamomum validinerve*, *Neolitsea zeylanica*, *Illicium griffithii*, *Quercus* sp., *Platycarya strobilacea*, *Eriobotrya benghalensis*, *E. japonica*, *E. sp.*, *Tirpitzia chinensis*, *Schefflera pes-avis*, *Calophyllum balansae*, *C. bonii*, *Dracaena cambodiana*, *Diospyros mun*, *Mitrephora calcarea*, *Diospyros* sp., *Xerospermum tonkinensis*, *Canthium dicoccum*, *Sinosideroxylon racemosum*, *Murraya koenigii*, *M. paniculata*, *Jasminum lanceolarium*, *J. longisetum*, *Trigonostemon bonianus*, *Drypetes perreticulatus*, *Paphiopedilum appletonianum*, *P. delenatii*, and *Dendrobium dentatum*.

Plants on slopes of limestone mountains

Plants growing on the slopes include some 200 species, of which there are 14 species of Pteridophytes, two species of Gymnospermae, and 184 species of Angiospermae. The common tree species include *Streblus ilicifolius*, *Dimerocarpus brennieri*, *Teonongia tonkinensis*, *Heritiera macrophylla*, *H. cucphuongensis*, *Pterospermum truncolobatum*, *P. heterophyllum*, and *Ficus gibbosa*. Many species of understory shrubs and herbs have large thin leaves, providing a large light-absorbing surface, notably species of Pteridophytes, Euphorbiaceae, Rubiaceae, Urticaceae, and Araceae.

Plants in the valleys

In valleys between limestone walls the humidity is high. The soil is of macgalis ferralit brown-yellow. The flora here includes 1,219 species belonging to Bryophyta, Pteridophyta and Angiospermae. Many tree species have straight unbranched trunks, or have buttresses or stilt roots providing additional support. Their glabrous leaves have drip tips probably to prevent water accumulating after rain. Examples are *Tetrameles nudiflora*, *Shorea chinensis*, *Terminalia myriocarpa*, *Anogeissus acuminata*, *Cinnamomum balansae*, *Pometia pinnata*, *Erythrophloeum fordii*, *Dracontomelum duperreanum*, and *Vatica harmandiana*.



FIG. 6. *Paris chinensis* (Trilliaceae).



FIG. 7. *Amorphophallus paeoniifolia* (Araceae).

Plants on non-limestone soil

This group has 440 species especially in the following genera: *Machilus*, *Phoebe*, *Litsea*, *Cinnamomum* (Lauraceae), *Aglaia*, *Amoora*, *Chisocheton*, *Dysoxylum*, *Heynea* (Meliaceae), *Castanopsis*, *Lithocarpus* (Fagaceae), *Elaeocarpus* (Elaeocarpaceae), *Macaranga*, *Endospermum*, *Bischofia*, and *Sapium* (Euphorbiaceae).

The distribution of plants in Cucphuong is interesting. The number of species decreases from the valley to the top of the mountains. The greatest number of Pteridophyte species occurs chiefly in the valleys and under the canopy of the forest.

DIVERSITY OF LIFE-FORMS

Life-forms are an ecological characteristic of every flora. Spectrum of the life-forms is truly a reflective mirror of ecological conditions as well as a primary or secondary character of the flora in the studied region, and also provides information on conservation and suitable use of the plant resources. On the basis of the classification categories of Raunkiaer (1934), the spectrum of the life-forms of the Cucphuong flora was established including five main groups as follows (Table 4, Fig. 8):

1. Phanerophytes (Ph).—This group includes 1,175 species in 151 families making up 60.44% of the total flora (Fig. 8). This dominant group includes seven subgroups.

1.1. Mega- and Meso-phanerophytes (MM).—This includes 260 large woody species taller than 8 m (13.37% of the total flora) (Fig. 9). The species-rich families are Lauraceae (37 sp.), Euphorbiaceae (22 sp.), and Moraceae (20 sp.). The high proportion of species belongs to the following families: Bignoniaceae 6/6 species, Buseraceae 6/6, Elaeocarpaceae 8/9, Fagaceae 10/12. Some large size species include *Shorea chinensis* (Dipterocarpaceae), *Tetrameles nudiflora* (Datiscaceae), *Terminalia myriocarpa* (Combretaceae), *Elaeocarpus* (Elaeocarpaceae), *Dracontomelum duperreanum* (Anacardiaceae), and *Cinnamomum balansae* (Lauraceae).

1.2. Microphanerophytes (Mi).—This includes 257 short woody species (2–8 m) (13.32% of the total flora) (Fig. 9). The species-rich families are Euphorbiaceae (15 sp.) and Annonaceae (14 sp.).

1.3. Nanophanerophytes (Na).—This includes 196 species in 46 families (10.08% of the total flora) (Fig. 9). The species-rich families are Rubiaceae (24 sp.), Myrsinaceae (20 sp.), Acanthaceae (19 sp.), Fabaceae (18 sp.), and Euphorbiaceae (17 sp.).

1.4. Lianphanerophytes (Lp).—This includes 222 species in 40 families (about 11.42% of the total flora) (Fig. 9). The species-rich families are Fabaceae (33 sp.) and Rubiaceae (18 sp.). This group is characteristic of

TABLE 4. Life-forms of Cucphuong flora.

Life-form	Number of species	Rate
1. Phanerophytes (Ph)	1175	60.44
1.1. Mega-Mesophanerophytes (MM)	260	13.37
1.2. Microphanerophytes (Mi)	257	13.32
1.3. Nanophanerophytes (Na)	196	10.08
1.4. Lianphanerophytes (Lp)	222	11.42
1.5. Epiphyte-phanerophytes (Ep)	221	11.37
1.6. Hemi- and Parasite-phanerophytes (Pp)	13	0.67
1.7. Herb phanerophytes (Hp)	6	0.33
2. Chamaephytes (Ch)	190	9.77
3. Hemicryptophytes (H)	225	11.57
4. Cryptophytes (Cr)	152	7.82
5. Therophytes (Th)	200	10.29

tropical forest especially woody liannas as *Entada*, *Acacia*, *Bauhinia*, *Strychnos*, *Melodinus*, and *Tetrastigma*.

1.5. *Epiphyte-phanerophytes (Ep)*.—This includes 221 species in 35 families going up to 11.37% of the total flora (Fig. 9). The species-rich families are Orchidaceae (48 sp.), Araceae (10 sp.).

1.6. *Hemiparasite- and Parasite-phanerophytes (Pp)*.—This include 13 species in four families and makes up about 0.67% of the total flora (Fig. 9).

1.7. *Herb-phanerophytes (Hp)*.—This includes six species or about 0.33% of the total flora (Fig. 9).

2. **Chamaephytes (Ch)**.—This group includes 190 species in 54 families (9.77% of the total flora) (Fig. 8). The species-rich families are Asteraceae (26 sp.), Fabaceae (24 sp.), Euphorbiaceae (14 sp.) and Acanthaceae (13 sp.).

3. **Hemicryptophytes (H)**.—This group includes 225 species in 46 families or 11.57% of the total flora (Fig. 8). The species-rich families are Poaceae (36 sp.), Orchidaceae (15 sp.), Thelipteridaceae (14 sp.) and Cyperaceae (14 sp.).

4. **Cryptophytes (Cr)**.—This group includes 152 species in 42 families constituting 7.82% of the total flora (Fig. 8). The species-rich families are Orchidaceae (25 sp.), Convallariaceae (20 sp.), Zingiberaceae (14 sp.) and Cyperaceae (11 sp.).

5. **Theophytes (Th)**.—This group is characteristic for grassland patches next to human activities or along swamps. It consist of 200 species in 41 families (10.29% of the total flora) (Fig. 8). The greatest number of species are chiefly in the Poaceae (35 sp.), Cyperaceae (27) and Asteraceae (26); they are light-loving.

In short, the spectrum of the life-forms of the Cucphuong flora is shown: SB (Spectrum of Biology) = 60.44 Ph + 9.77 Ch + 11.57 H + 7.82 Cr +

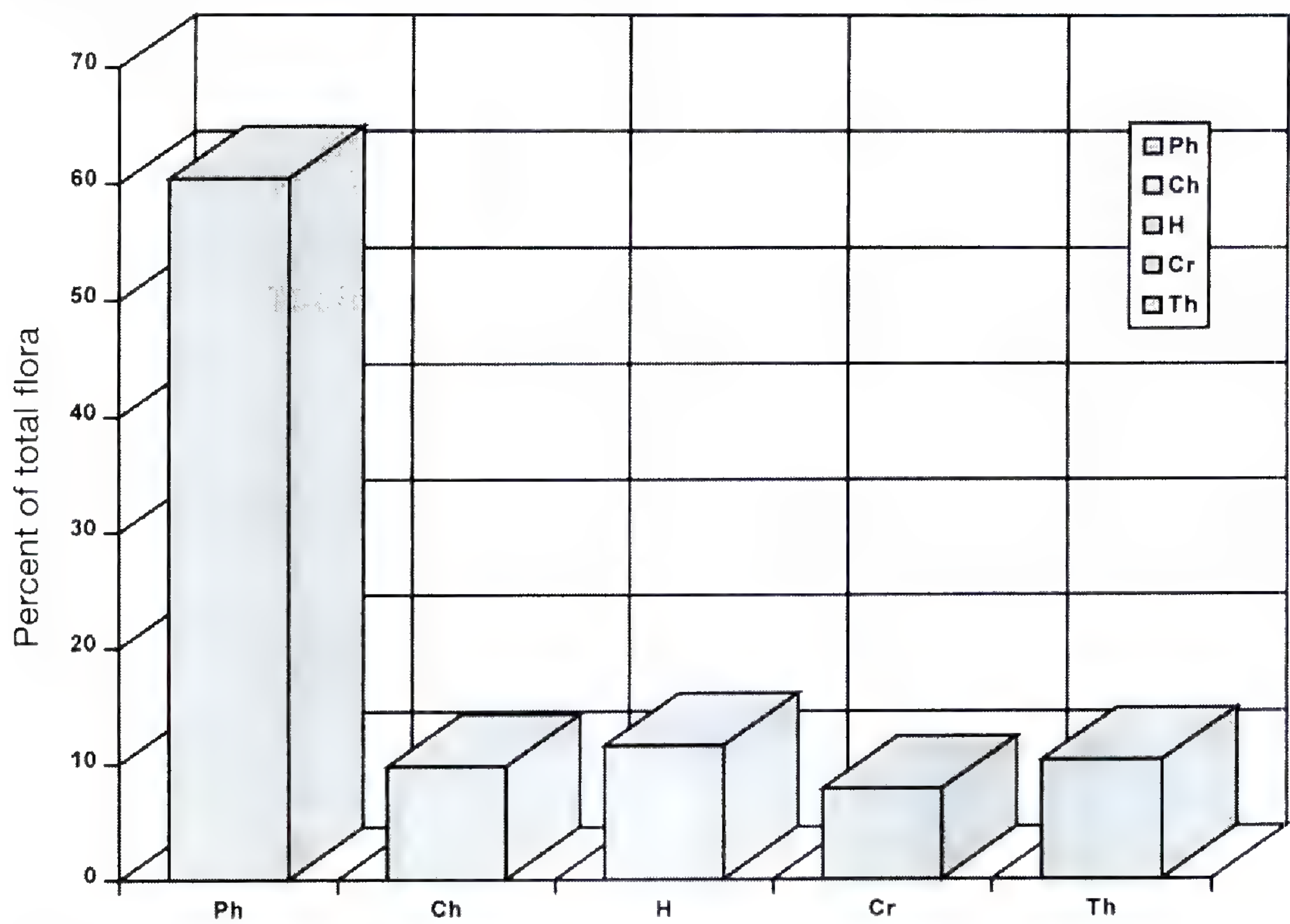


FIG. 8: Spectrum of main life-form groups of Cucphuong flora.

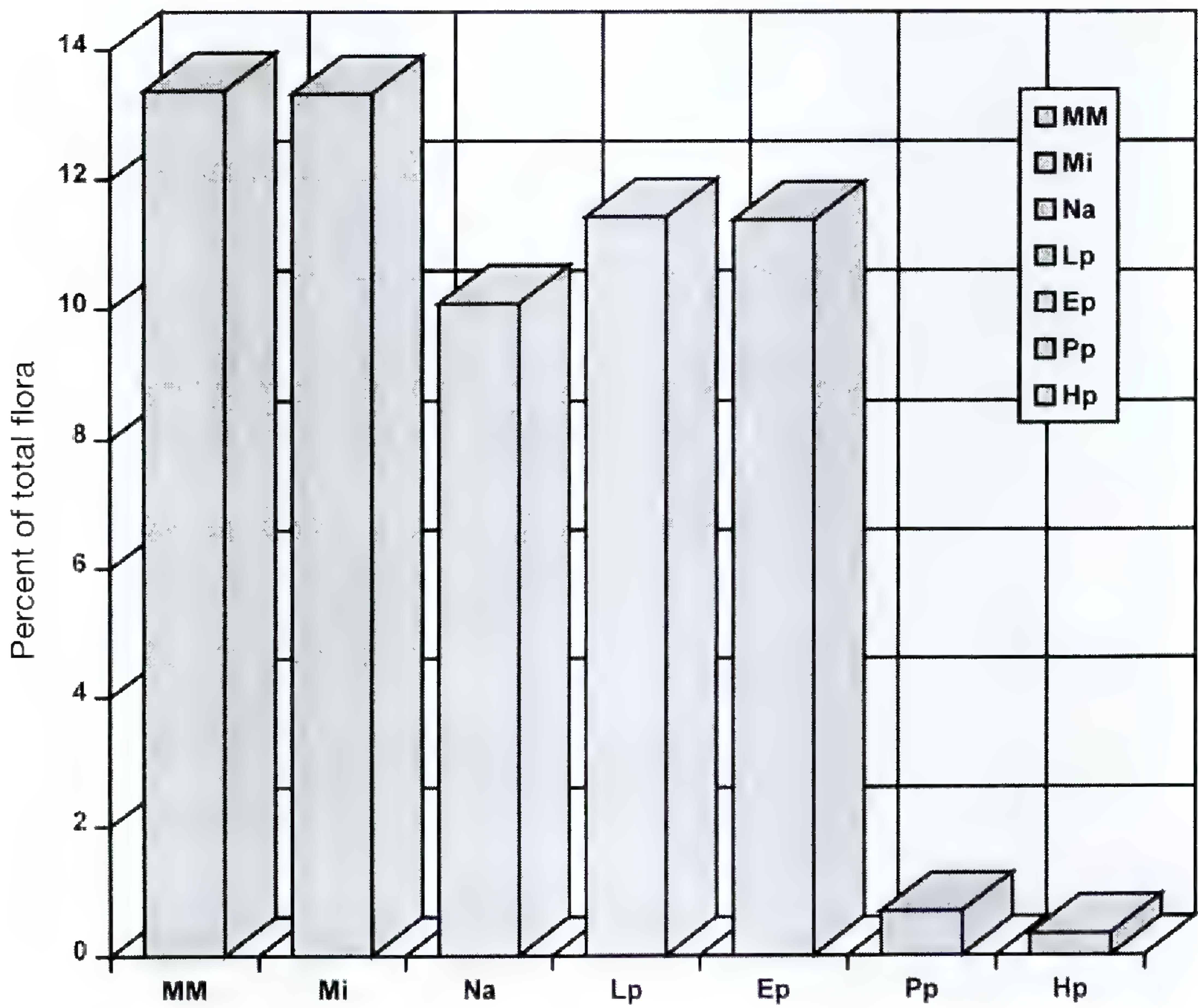


FIG. 9: Spectrum of subgroups of phanerophytes life-form of Cucphuong flora.

10.29 Th, in which $Ph = 13.37 \text{ MM} + 13.32 \text{ Mi} + 10.08 \text{ Na} + 11.42 \text{ Lp} + 11.37 \text{ Ep} + 0.67 \text{ Pp} + 0.33 \text{ Hp}$.

If making comparison with the spectra of life-forms from North Vietnam (Pocs 1965a) and from Lamson, Luongson, Hoabinh (Le Tran Chan, Phan Ke Loc, Nguyen Nghia Thin, Nong Van Tiep, 1994) where is near the Cucphuong National Park but destroyed seriously by human activities (Figs. 1, 2) it is clear that the Cucphuong flora is much more primary than the North in general and the Lamson flora in particular. This is shown by high rate of Phanerophytes group and low of Chamaephytes, Hemicryptophytes and Cryptophytes.

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APPENDIX

CHECKLIST OF SPECIES FOUND IN THE CUCPHUONG NATIONAL PARK

Format: Distribution and soil type follows: V—Valleys, SL—Slopes of limestone mountains, SUM—Summits of limestone mountains, NL—Non-limestone soil.

Life-forms: Ph—Phanerophytes including MM—Mega-or Meso-phanerophytes, Mi—Microphanerophytes, Nan—Nanophanerophytes, Lp—Liana-phanerophytes, Ep—Epiphyte—phanerophytes, Pp—Parasite or Hemiparasite-phanerophytes, Hp—Herb-phanerophytes; Ch—Chamaephytes; H—Hemicryptophytes; Cr—Cryptophytes; Th—Theophytes.

BRYOPHYTA

ANTHOCEROPSIDA

ANTHOCROTACEAE

Anthoceros miyabenus Steph., V

MARCHANTIOPSIDA

FRULLANIACEAE

Frullania grandipula Lindenb., V

Frullania moniliata (Reinw. Blume & Nees)
Nees, V

LEJEUNEACEAE

Aphanolejeunea proboscoidea Goeb., V

Cheilolejeunea meyeniana (Steph.) Kach. &
Schust., V

Cololejeunea appressa Bx., V

Cololejeunea bichiana Tixier, V

Cololejeunea crysanthemii Tixier, V

Cololejeunea dankianensis Tixier, V

Cololejeunea floccosa (L. & L.) Steph., V

Cololejeunea formosana Miz., V

Cololejeunea grushvitzkiana Pocs, V

Cololejeunea haskarliama (Gott.) Bx., V

Cololejeunea karstenii Steph., V

Cololejeunea lanciloba Steph., V

Cololejeunea ninbinhiana Tixier, V

Cololejeunea nymanii Steph., V

Cololejeunea tramninhiana Tixier, V

Colura acutifolia Ast., V

Colura ari Steph., V

Lejeunea flava (Sw.) Nees, V

Leptolejeunea balansae Steph., V

Leptolejeunea subacuta Steph., V

Leptolejeunea vitrea (Nees) Steph., V

Lopholejeunea vietnamica Tixier, V

LOPHOCOLEACEAE*Heterocyphus argutus* (Nees) Schiffn., V**MARCHANTIACEAE***Marchantia palmata* Nees, V**PLAGIOCHILACEAE***Plagiochila acanthophylla* Gott., V*Plagiochila fissifolia* Steph., V*Plagiochila fordiana* Steph., V*Plagiochila subplanata* Inoue H., V**RADULACEAE***Radula acuminata* Steph., V**BRYOPSIDA****AMBLYSTEGIACEAE***Scriaroniopsis bonianum* (Besch.) Tixier, V**BARTRAMIACEAE***Philonotis revoluta* Bosch & Lacout., V**BRANCHYTHERIDIACEAE***Cirriphyllum oxyrrhynchum* (Doz. & Molk.) M. Fleisch., V*Rhynchostegium aciculum* (Broth. & Par.) M. Fleisch., V*Rhynchostegium colebicum* (Lacout.) Jaeg., V*Rhynchostegium vagans* (Harv.) Jaeg., V**BRYACEAE***Bryum ambiguum* Duby., V**CALYMPERACEAE***Syrrophodon larmitani* M. Fleisch., V**DALTONIACEAE***Cyathophorella tonkinensis* (Broth. & Par.) Broth., V**DICRANACEAE***Dicranella eustegia* (C. Muell.) Bosch & Lacout., V*Holomitrium griffithianum* Mitt., V*Leucoloma molle* (C. Muell.) Mitt., V*Leucophanes candidum* (Hornsch.) Lindl., V*Trematodon longicollis* Michx., V**ENTODONTACEAE***Erythrodontium flarascens* (Hook.) Bosch & Lacout., V*Erythrodontium julaceum* (Hook.) Par., V*Tetrachyphyllum inflexum* (Harv.) Gepp., V**FABRONIACEAE***Campylodontium flavascochs* (Hook.) Bosch & Lacout., V**FISSIDENTACEAE***Fissidens hollianus* Doz. & Hook., V*Fissidens incertus* Ther., V*Fissidens nobilis* Griff., V*Fissidens sylvaticus* Griff., V*Fissidens sollingeri* Montg., V**FUNARIACEAE***Physcomitrium repandum* (Griff.) Mitt., V**HOOKERIACEAE***Callicestella papillata* Mitt., V*Distichophyllum nigricaulis* Doz. & Molk., V*Hypopterigium apiculatum* Thwait. & Mitt., V*Hypopterigium aristatum* Bosch & Lacout., V*Hypopterigium tenellum* C. Muell., V*Hypopterigium vriesei* Bosch & Lacout., V*Lopodium trichocladon* (Bosch & Lacout.) M. Fleisch., V**HYPNACEAE***Ectropothecium chamissonis* (Hernsch.) Jaeg., V*Ectropothecium monumentorum* (Duby.) Jaeg., V*Isopterygium chlorophyllum* Bosch, V*Isopterygium lignicola* (Mitt.) Jaeg., V*Isopterygium pobliaecarpum* (Sull. & Leag.) Jaeg., V*Taxiphyllum taxirameum* (Mitt.) M. Fleisch., V*Vesicularia reticulata* (Doz. & Molk.) Broth., V*Vesicularia tonkinensis* (Bosch) Broth., V**METEORIACEAE***Aerobryidium filamentosum* (Hook.) M. Fleisch., V*Aerobryopsis deflexa* Broth. & Par., V*Aerobryopsis longissima* (Doz. & Holk.) M. Fleisch., V*Floribundaria pseudofloribunda* M. Fleisch., V*Meteoriopsis buchanani* (Brid.) M. Fleisch., V*Meteoriopsis squarrosa* (Hook.) M. Fleisch., V**MNIACEAE***Plagionium rostratum* (Schrader.) Kop. T., V*Plagionium succulentum* (Schard.) Kop. T., V**NECKERACEAE***Calyptothecium wrightii* Mitt., V*Himantocladium plumula* (Nees) M. Fleisch., V*Homaliodelphus targionianus* (Mitt.) Dix., V*Homaliodendron exiguum* (Bosch & Lacout.) M. Fleisch., V*Homaliodendron flabellatum* (Dicks.) M. Fleisch., V*Homaliodendron microdendron* (Bont.) M. Fleisch., V*Homaliodendron scalpellifolium* (Mitt.) M. Fleisch., V*Neckeropsis moutieri* (Broth. & Par.) M. Fleisch., V*Neckeropsis lepianeana* (Hpe ex C. Muell.) Toun., V

Neckeropsis semperiana (Mont.) M. Fleisch., V
Pinnatella alopecuroides (Hook.) M. Fleisch., V
Pinnatella ambigua (Lacout.) M. Fleisch., V
Pinnatella donghamensis Besch., V
Pinnatella kubliana (Lacout.) M. Fleisch., V
Pinnatella microptera (C. Muell) M. Fleisch., V

ORTHOTRICHACEAE

Macromitrium gymnostorum Sull & Lesq., V
Macromitrium nepalense (H. & G.) Schwaegr., V

PHYLLOGONIACEAE

Horikawaea nitida Nog., V

POTTIACEAE

Hyogonium pseudochenbergi (M. Fleisch.) Chen., V
Hymenotomum involuta (Hook.) Jaeg., V
Hyophyla involuta (Hook.) Jaeg., V
Pseudosymblepharis papillesula (Curd. & Their.) Broth., V
Trichostomum involutum Broth., V
Trichostomum perivolutum Tixier, V
Weisia longidens Card., V

PTEROBRYACEAE

Garovaglia crispata Tixier, V
Garovaglia powellii Besch., V

RACOPILACEAE

Racopilum schmidii (C. Muell.) Mitt., V

SEMATOPHYLLACEAE

Acanthodadium pocsii Tixier, V
Acanthorrhynchium papillatum (Harv.) M. Fleisch., V
Glossadelphus boutanii (Broth. & Far.) Broth., V
Sematophyllum subhumile (C. M.) M. Fleisch., V
Taxithelium instratum (Brid.) Broth., V
Taxithelium isooladium (Lacout.) Reh. & Card., V

TRACHYPODIACEAE

Diaphanodon blanius (Harv.) M. Fleisch., V
Pseudospiridentopsis horrida (Card.) M. Fleisch., V

THUIDIACEAE

Anomodon tonkinensis Besch., V
Claopodium aciculum (Broth.) Broth., V
Claopodium assurgens (Sull. & Lesg.) Card., V
Haplocladium minutifolium Their., V
Haplocladium sublanceum (Mitt.) Broth., V
Haplobymerium pseudotriste (C. Muell) Broth., V
Herpetineuron tocaea (Sull. & Lesg.) Ren. & Card., V
Pelekium velatum Mitt., V
Thuidium bonianum Besch., V

Thuidium cymbifolium (Dz. & Molk.) Bosch & Lacout., V

Thuidium meyenianum (Hpe.) Bosch & Lacout., V

Thuidium tamaricellum (Mitt.) Bosch & Lacout., V

PSILOTOPHYTA

PSILOTACEAE

Psilotum nudum (L.) Griseb. (*P. triquetrum* Sw.), SL, Ep

LYCOPODIOPHYTA

LYCOPODIACEAE

Lycopodium carinatum Desv., SUM, Ep
Lycopodium cernuum L., NL, H

SELAGINELLACEAE

Selaginella biformis A. Br. ex Kuhn, V, H
Selaginella decipiens Warb., V, H
Selaginella intermedia (Blume) Spring, V, H
Selaginella pubescens (Wall.) Spring, V, H
Selaginella siamensis Hieron., V, H
Selaginella tamariscina (Beauv.) Spring, V, H
Selaginella wallichii (Hook. & Griev.) Spring, V, H

EQUISETOPHYTA

EQUISETACEAE

Equisetum ramocissimum Desf., NL, Cr
 ssp. *debile* (Roxb.) Hauke (*E. debile* Roxb.)

POLYPODIOPHYTA

ADIANTACEAE

Adiantum caudatum L., SL, H
Adiantum flabellulatum L., V, H
Cheilanthes tenuifolia (Burm.) Sw., V, Th

ASPLENIACEAE

Asplenium antrophyoides Christ, V, H
Asplenium belangeri (Bory) Kze, SL, H
Asplenium grevillei Wall., SL, H
Asplenium aff. *grevillei* Wall., SL, H
Asplenium griffithianum Hook., NL, H
Asplenium nidus L., NL, Ep
Asplenium pseudolaserpitiifolium Ching, V, Ep
Asplenium saxicola Ros., SL, H
Asplenium unilaterale Lam., V, H

AZOLLACEAE

Azolla imbricata (Roxb.) Nakai, NL, Th

BLECHNACEAE

Blechnum orientale L., NL, Ch
Stenochlaena palustris (Burm.) Bedd., NL, Ch

CYATHEACEAE

- Cyathea podophylla* Cop., V, N
Cyathea aff. *contaminans* (Wall.) Cop., V, Mi

DAVALLIACEAE

- Arthropteris obliterated* (R. Br.) J. Sm., V, H
Davallia formosana Hay., V, H (*Davallia divaricata* Blume) var. *orientalis* Tard.-Blot & C. Ch.
Humata repons (L.f.) Diels, SUM, Ep
Nephrolepis cordifolia (L.) Presl, SL, H
Nephrolepis falcata (Cav.) G. Ch., V, H

DENNSTAEDTIACEAE

- Lindsaea orbiculata* (Lam.) Mett. ex. Kuhn, SL, H
Microlepia hokeriana (Wall.) Fresl, V, H
Microlepia marginata (Houtt.) C.Chr., V, H
Microlepia speluncae (L.) Moore, V, H
Microlepia speluncae (L.) Moore var. *hancei* C. Chr. & Tard.-Blot, V, H
Schizoloma ensifolium (Sw.) J. Sm., SL, H
Schizoloma heterophyllum (Dry.) J. Sm., SL, Cr
Stenoloma chusanum Ching, V, Cr

DICKSONIACEAE

- Cibotium barometz* (L.) J. Sm., V, Ch

DRYOPTERIDACEAE

- Ctenitopsis* sp., V, H
Cyclopeltis aff. *crenata* (Fee) C. Chr., V, Cr
Hemigramma decurrens (Hook.) Cop., V, H
Quercifilix zeylanica (Houtt.) Cop., NL, H
Tectaria decurrens (Presl) Cop., V, H
Tectaria devexa Cop., V, H
Tectaria leuana Cop., V, H
Tectaria quinquefida Ching, V, H
Tectaria simonsii (Bedd.) Ching, V, H
Tectaria subtriphylla (Hook. & Arn.) Cop., NL, H
Tectaria variolosa (Wall.) C. Chr., V, H

GLEICHENIACEAE

- Dicranopteris linearis* (Burm. f.) Underw., NL, Cr (*Gleichenia linearis* Clarke)

GRAMMITIDACEAE

- Prosaptia* aff. *urceolaris* Cop. var. *intermedia* (Ching) Ching, SL, H

HYMENOPHYLLACEAE

- Crepidomanes bipunctatum* (Poir.) Cop., V, H (*Trichomanes bipunctatum* Poir.)
Mecodium exsertum (Wall.) Cop., V, Ep (*Hymenophyllum exsertum* Wall.)
Microgonium beccarianum (Cesati) Cop., SL, Ep (*Trichomanes motleyi* v. d. B.)
Vandenboschia auriculata (Blume) Cop., SL, Ep (*Trichomanes auriculatum* Blume)

- Vandenboschia cystosciroides* (Christ) Ching, SL, Ep (*Trichomanes cystosciroides* G. Christ)

LOMARIOPSIDACEAE

- Bolbitis heteroclita* (Presl) Ching, NL, Ch
Lomariopsis spectabilis Mett., NL, Ep

MARATTIACEAE

- Angiopteris* aff. *repandula* de Vriese, V, H
Archangiopteris sp., V, H

MARSILEACEAE

- Marsilea minuta* L., NL, Cr
Marsilea aquatifolia L., NL, Cr

OPHIOGLOSSACEAE

- Helminthostachys zeylanica* (L.) Hook., NL, Cr

PARKERIACEAE

- Ceratopteris thalictroides* Brongn., NL, Th

POLYPODIACEAE

- Colysis bonii* Ching, V, Ch
Colysis digitata (Bak.) Ching f. *digitata*, V, Ep f. *annamensis* C.Chr. & Tard. Blot
Colysis dissimialata Ching, V, Ch
Colysis pothifolia (D. Don) Presl, V, Ep (*Colysis elliptica* Ching var. *pothifolia* Ching)
Colysis wrightii Ching, V, Ep
Colysis sp1., V, Ep
Colysis sp2., V, Ep
Drynaria fortunei (Kuntze) J.Sm., SL, Ep
Lemmaphyllum microphyllum Presl var. *obovatum* (Harr.) C.Chr., NL, Ep
Leptochilus laciniatus Ching var. *simplex* Ching, V, Ep
Loxogramme lankokiensis C.Chr., V, Ep
Microsorium dilatatum (Bedd.) Sledge, V, Ch (*M. hancocki* (Bak.) Ching)
Microsorium steerei Ching, V, Ch
Neocheiropteris phyllomanes (Christ) Ching, SL, Ch
Phymatosorus longissima (Moore) J. Sm., V, Ch
Phymatosorus sp., SL, Ch
Pseudodrynaria coronans (Wall.) Ching, V, Ep (*Aglaomorpha coronans* Cop.)
Pyrrhosia adnascens (Sw.) Ching, V, Ep
Pyrrhosia flocculosa Ching, SL, Ch
Pyrrhosia lingua (Thunb.) Farwell, SL, Ch
Pyrrhosia tonkinensis (Gies.) Ching, V, Ep

PTERIDACEAE

- Pteridium aquilinum* Kuhn, NL, Ch
Pteris cadieri Christ, NL, H
Pteris dissitifolia Bak., NL, H (*P.semipinnata* L. var. *dissitifolia* Tard.-Blot & C. Chr.)
Pteris ensiformis Burm., SL, H
Pteris fenotii Christ, SL, H
Pteris grevilleana Wall., SL, H

Pteris kbasyana Hier., V, H
Pteris longipes D. Don, V, H
Pteris oshimensis Hier., V, H
Pteris semipinnata L., V, H

SALVINIACEAE

Salvinia cucullata Hoffm., NL, Th
Salvinia natans (L.) All., NL, Th

SCHIZAEACEAE

Lygodium conforme C. Chr., V, Cr
Lygodium flexuosum (L.) Sw., NL, Cr
Lygodium flexuosum (L.) Sw. var. *alata* Clarke, NL, Cr
Lygodium japonicum (Thunb.) Sw., NL, Cr
Lygodium microstachyum Desv., NL, Cr
Lygodium polystachyum Wall., NL, Cr
Lygodium scandens (L.) Sw., NL, Cr
Lygodium subareolatum Christ, NL, Ch

THELYPTERIDACEAE

Abacopteris cuspidatus Ching, NL, H (*Cyclosorus cuspidatus* Tard.-Blot)
Abacopteris simplex (Hook.) Ching, NL, H (*Cyclosorus triphyllus* Tard.-Blot var. *simplex* Hook.)
Abacopteris triphylla (Sw.) Ching, NL, H (*Cyclosorus triphyllus* Tard.-Blot)
Abacopteris urophylla Ching, NL, H (*Cyclosorus urophylla* Tard.-Blot)
Cyclosorus balansae C. Chr. & Tard.-Blot, V, H
Cyclosorus clarescens Ching, V, H
Cyclosorus papillic Tard.-Blot, V, H
Cyclosorus parasiticus (L.) Farwell., V, H
Cyclosorus proliferus Tard.-Blot, V, H
Cyclosorus sophoroides Tard.-Blot, V, H
Cyclosorus truncatus Ito, V, H
Cyclosorus unitus Ching, V, H
Cyclosorus sp1., V, H
Cyclosorus sp2., V, H
Thelypteris singaiaensis Ching, V, H
Thelypteris tonkinensis Ching, V, H

VITTARIACEAE

Antrophyum callifolium Blume, V, Ep
Antrophyum coriaceum Wall., V, Ep
Antrophyum sp., V, Ep
Vittaria elongata Sw., V, Ep var. *merrillii* C. Chr. & Tard.-Blot var. *zosterifolia* C. Chr. & Tard.-Bot
Vittaria flexuosa Fee, V, Ep
Vittaria hainnanensis C. Chr., V, Ep

WOODSIACEAE

Callipteris esculenta (Retz.) J. Sm., V, H
Diplaziopsis sp., V, H
Diplazium donianum (Mett.) Tard.-Blot, V, H

Diplazium maximum C. Chr., V, Ch
Diplazium pinnatifido-pinnatum Moore, V, H
Diplazium sp., V, H

PINOPHYTA

CYCADACEAE

Cycas balansae Warb., SL, Na

GNETACEAE

Gnetum montanum Mgf., SL, Lp

PODOCARPACEAE

Podocarpus fleuryi Hickel, SL, MM

MAGNOLIOPHYTA

MAGNOLIOPSIDA

ACANTHACEAE

Barleria lupulina Lindl.-Gaidk., V, Na
Codonacanthus pauciflorus (Nees) Nees, V, Ch
Dicliptera chinensis (L.) Nees, V, Th
Eranthemum nervosum Roem., V, Ch
Hygrophila angustifolia R. Br., V, Ch
Hygrophila phlomoides Nees, V, Ch
Justicia equitans R. Ben., V, Ch
Justicia gendarusa R. Ben., NL, Na
Justicia pauperula R. Ben., NL, Na
Justicia procumbens L., NL, Ch
Justicia vagabunda R. Ben., V, Ch
Justicia ventricosa Wall., V, Na
Justicia sp1., V, Ch
Justicia sp2., V, Ch
Justicia sp3., V, Na
Peristrophe roxburghiana (Schult.) Brem., NL, Ch (*P. tinctoria* Nees)
Phlogacanthus colaniae R. Ben., NL, Na
Phlogacanthus curviflorus Nees, V, Na
Phlogacanthus sp., V, Na
Pseuderanthemum crenulatum Lindl., V, Na
Pseuderanthemum palatiferum Radlk., V, Na
Pseuderanthemum poilanei R. Ben., V, Na
Pseuderanthemum tonkinensis R. Ben., V, Na
Rhinacanthus calcaratus Nees, V, Na
Rhinacanthus communis Nees, NL, Na
Ruellia flagelliformis Roxb., NL, H
Ruellia repens L., V, Ch
Rungia tonkinensis R. Ben., V, Ch
Rungia sp., V, Ch
Sphinetacanthus sp., V, Na
Strobilanthes acrocephalus T. Anders., V, H
Strobilanthes brunnescens R. Ben., V, Na
Strobilanthes dalzielii (Smith.) R. Ben. var. *inaequalis* R. Ben., V, Na
Strobilanthes lilacinus Clarke, V, Na
Strobilanthes multangurus R. Ben., V, Na

Thunbergia eberhardtii R. Ben., V, Lp
Thunbergia grandiflora Roxb. var. *cordifolia* R.
 Ben., V, Lp

ACERACEAE

Acer decandrum Merr., V, MM
Acer oblongum Wall., V, Mi
Acer tonkinensis Lecomte, SL, Mi
Acer sp., SL, Mi

ACTINIDIACEAE

Saurauia tristyla DC., NL, Mi

ALANGIACEAE

Alangium barbatum (R.Br.) Baill. var. *decipens*
 (Evrard) Tardieu-Blot, V, Mi (*A. decipiens*
 Evrard)
Alangium chinensis (Lour.) Rehd., V, MM
Alangium kurzii Craib, V, MM
Alangium salvifolium (L.f.) Wang., SL, Lp

AMARANTHACEAE

Achyranthes aspera L., V, H
Achyranthes bidentata Bl., V, H
Alternanthera sessilis (L.) R. Br. ex Roem., NL,
 Th
Amaranthus spinosus L., NL, Th
Celosia argentea L., NL, Th
Celosia argentea L. var. *cristata* Moq., NL, Th
 (*Celosia cristata* Miq.)
Cyathula prostrata (L.) Blume, NL, Ch
Deeringia amaranthoides (Lam.) Merr., V, Lp

ANACARDIACEAE

Dracontomelum duperreanum Pierre, V, MM
Drymicarpus racemosus Hook., V, Mi
Mangifera foetida Lour., V, MM
Pegia sarmentosa (H. Lec.) Hand.-Maz., V, Lp
 (*Phlebochiton sarmentosum* H. Lec.)
Pistacia cucphuongensis Dai, SUM, Mi
Pistasia weinmanifolia Poiss. ex Franch. var.
symplex Wu & Ifang., SUM, Mi
Rhus chinensis Muller, V, Mi (*Rhus semialata*
 Murr.)
Choerospondias axillaris (Roxb.) Burtt. & Hill,
 V, MM
Spondias lakonensis Pierre, V, MM
Spondias pinnata (L.f.) Kurz, V, MM (*S.*
mangifera Will.)
Toxicodendron rhesoides (Craib) Tard., V, Mi
Toxicodendron succedanea (L.) Moldenke, V, Mi

ANNONACEAE

Alphonsea boniana Finet & Gagnep., SL, MM
Alphonsea squamosa Finet & Gagnep., SL, MM
Alphonsea tonkinensis Aug. DC., SL, Mi
Alphonsea sp., SL, Mi
Annona reticulata L., NL, Mi
Annona squamosa L., V, Mi

Artabotrys vinhensis Ast., NL, Lp
Dasymaschalon rostratum Merr. & Chun. var.
glaucum (Merr. & Chun) Ban, NL, Mi (*D.*
glaucum Merr. & Chun)
Dasymaschalon sp., NL, Mi
Desmos cambodius (Pierre) Ast., NL, Mi
Desmos cochinchinensis Lour., NL, Lp
Desmos dubius Hook., NL, Lp
Desmos latifolium Hook., NL, Lp
Goniotalamus tamirensis Pierre, NL, Na
Fissistigma glaucescens (Hance) Merr., NL, Lp
Fissistigma latifolium Hook., NL, Lp
Fissistigma maclurei Merr., NL, Lp
Fissistigma poilanei (Ast.) Tsiang & Li, NL, Lp
 (*Melodorum poilanei* Ast.)
Fissistigma schefferi Pierre, NL, Lp
Miliusa balansae Finet & Gagnep., NL, Mi
Miliusa campanulata Pierre, NL, Mi
Miliusa filipes Merr., NL, Mi
Miliusa mollis Pierre, NL, Mi
Mitrephora calcarea Diels, V, MM
Mitrephora maingayi Hook., V, Mi
Mitrephora pallens Ast., V, Mi
Mitrephora trimetra Craib, V, Mi
Polyalthia consanguinea Merr., V, MM
Polyalthia laui Merr., V, MM
Uvaria boniana Finet & Gagnep., V, Lp
Uvaria cordata (Dun.) Wall. ex Alston, V, Lp
 (*U. macrophylla* Roxb.)
Uvaria tonkinensis Finet & Gagnep., V, Lp

APIACEAE (UMBELLIFERAE)

Centella asiatica (L.) Urb., NL, H
Cnidium monnieri (L.) Cuss., NL, Th
Eryngium foetidum L., NL, H
Hydrocotyle javanica Thunb., V, H
Hydrocotyle sibthorpioides Lam., V, H

APOCYNACEAE

Alstonia scholaris (L.) R. Br., SL, MM
Alyxia divaricata Pitard, SL, Lp
Beaumontia grandiflora Wall., SL, Lp
Chonemorpha eriostylis Pitard var. *baviensis*
 Pitard, SL, Lp
Cirbera manghas L., NL, MM
Ecdysanthera rosea Hook., SUM, Lp
Ervatamia bonii (Pitard) Pichon, V, Na
 (*Tabernaemontana bonii* Pitard)
Ervatamia bovina (Lour.) Markgr., V, Na (*T.*
tonkinensis Pitard, *T. repoensis* Pierre ex Pitard)
Holarrhena antidysenterica (Roxb. & Flem.)
 A.DC., V, MM
Holarrhena similis Craib., NL, Mi
Kitabalia macrophylla (Pierre) Woodson, V, Mi
Kitabalia microphylla (Pitard) Woodson, SL, Mi
Kopsia tonkinensis Pitard, SL, Na
Melodinus annamensis Pitard, SL, Lp

Melodinus erianthus Pitard, SL, Lp
Melodinus tonkinensis Pitard, SL, Lp
Plumeria acutifolia Poir., SUM, Mi
Parsonsia spiralis Wall., SUM, Lp
Pottsia cantonensis Hook., SL, Lp
Pottsia laxiflora (Blume) Kuntze, SL, Lp
Rauwolfia cambodiana Pierre ex Pitard, V, Mi
Rhynchodia capusii Pierre, V, Lp
Spirolobium cambodianum Baill., SUM, Lp
Strophanthus divaricatus (Lour.) Hook. & Arn.,
 NL, Mi (*S. divergens* Grah.)
Wrightia annamensis Dub. & Eberh., NL, Mi
Wrightia laevis Hook.f., SUM, Mi (*W. balansae*
 Pitard)
Wrightia sikkimensis Gamble, SUM, Mi (*W.*
stellata Pitard)
Wrightia tomentosa (Roxb.) Roem. & Schult.,
 SUM, Mi
Wrightia reynandii (Jum.) Pitard, SL, Lp

AQUIFOLIACEAE

Ilex cinerea Champ., V, Ch
Ilex memecylifolia Champ., V, Mi
Ilex purpurea Hassk. var. *nervosa* Loesn., V, MM
Ilex rotunda Thunb., V, MM

ARALIACEAE

Aralia armata (Wall. ex G. Don) Seem., NL,
 Lp
Aralia chinensis L., NL, Mi
Aralia thomsonii C.B. Clark var. *thomsonii*, SL,
 Ch var. *petiolulosa* Ha
Aralia vietnamensis Ha, SL, Na
Brassaiopsis glomerulata (Blume) Regel., SL, Mi
Brassaiopsis bainla (Ham.) Seem., SL, Na
Brassaiopsis varianalis Shang, V, Na
Heteropanax fragran (Roxb.) Seem., SL, MM
Macropanax oreophilus Miq., SL, Mi
Schefflera globulifera Grushv. & Skvorts., SL, Na
Schefflera glomerulata Li, SL, Na
Schefflera leucantha R. Vig., SL, Lp
Schefflera nitidifolia Harm., SL, Na
Schefflera octophylla (Lour.) Harm., NL, Mi
Schefflera petelotii Merr., SL, Mi
Schefflera ps-alis R. Vig., SUM, Na
Schefflera tonkinensis R. Vig., SL, Na
Trevesia sphaerocarpa Grushv., V, Mi

ARISTOLOCHIACEAE

Aristolochia aff. *dongnaiensis* Pierre, V, Lp
Aristolochia sp1., V, Lp
Aristolochia sp2., V, Lp
Aristolochia sp3., V, Lp

ASCLEPIADACEAE

Asclepias curassavica L., NL, Ch
Congronema sp., V, Lp
Cryptolepis buchananii Roem. & Sch., V, Lp

Cynanchum corymbosum Wright., V, Lp
Dischidia acuminata Cost., SL, Ep
Dischidia alboflava Cost., SL, Ep
Dischidia sp., SL, Ep
Dregea sp., V, Ch
Gymnema latifolia Wall., SL, Ch
Hoya bonii Cost., SL, Ep
Hoya multiflora Blume, SL, Ep
Hoya villosa Cost., SL, Ep
Hoya sp., SL, Ep
Marsdenia balansae Cost., SL, Ch
Marsdenia tinctoria Br., SL, Ch
Marsdenia urceolata Decne., SL, Ch
Myriopteron sp., SL, Ch
Oxystalma esculentum Br., SL, Ch
Secamone bonii Cost., SL, Ch
Streptocaulon griffithii Hook., NL, Ch
Telosma cordata (Burm. f.) Merr., NL, Ch
Toxocarpus griffithii Decne, NL, Lp
Toxocarpus bossensii Schlechter, NL, Lp
Toxocarpus villosus Decne., NL, Lp
Toxocarpus villosus Decne., var. *brevistylis* Cost.,
 NL, Lp

ASTERACEAE

Adenostemma viscosum Forst., V, Ch
Ageratum conyzoides L., V, Th
Artemisia carviflora Wall., NL, Th
Artemisia vulgaris L., NL, Ch
Aster trinervius Roxb., NL, Th
Bidens bipinnata L., NL, Th
Bidens pilosa L., NL, Th
Blumea balsamifera (L.) DC., V, Ch
Blumea glomerata DC., NL, Ch
Blumea hieracifolia DC., NL, Ch
Blumea honkongensis Vaniot, NL, Ch
Blumea laciniata (Roxb.) DC., NL, Ch
Blumea lanceolaria (Roxb.) Druce, V, Ch (*B.*
mycriocephala DC.)
Blumea procera DC., NL, Ch
Blumea pubigera Merr., NL, Ch (*B. chinensis* (L.)
 DC.
Blumea sp., NL, Ch
Capasium abrotanoides L., NL, Ch
Chromolaena nodiflorum (DC.) Sch.-Bip., V, Ch
Chromolaena odoratum (L.) King & Robinson,
 NL, Ch
Chromolaena revesii (Wall.) Sch.-Bip., V, Ch
Cnicus chinensis Maxim., NL, Ch
Cnicus japonicus Maxim., NL, Ch
Conyza viscidula Wall., NL, Lp
Cotula anthemoides Lour., NL, Ch
Crassocephalum crepidioides (Benth.) S. Moore,
 NL, Th
Crepis bonii Gagnep., NL, Th
Crepis japonica Benth., NL, Th

Dicrocephala latifolia (Lam.) DC., NL, Th
Eclipta alba Hassk., V, Th
Elephantopus bodinieri Gagnep., V, Ch
Elephantopus scaber L., V, H
Emilia sonchifolia DC., V, Th
Endydra fluctuans Lour., NL, H
Erigeron canadense L., NL, Th
Gnaphalium indicum L., NL, Th
Gnaphalium luteo-album L., NL, Th
Grangea maderaspatana Poir., NL, Th
Gynura procumbens (Lour.) Merr., NL, Cr (*G. sarmentosa* DC.)
Gynura pseudochina DC., NL, Cr
Gynura sp., NL, Cr
Hemistepta lyrata Bunge, NL, Th
Inula lappa DC., NL, Th
Lactuca indica L., NL, Th
Parthenium hysterophorus L., V, Th
Pluchea indica Less., NL, H
Rhynchospermum verticillatum Reinw., NL, Ch
Senecio scandens D. Don, NL, Ch
Senecio sp., V, Ch
Siegesbeckia orientalis L., NL, Th
Sphaeranthus africanus L., NL, Ch
Spilanthus acmella L., NL, Th
Synedrella nodiflora Gaertn., V, Th
Thespis tonkinensis Gagnep., V, Th
Tridax procumbens L., NL, Th
Vernonia andersoni Clarke, NL, Ch
Vernonia arborea Ham., NL, MM
Vernonia cinerea Less., NL, Th
Vernonia divergens Benth., NL, Ch
Vernonia patula Merr., NL, Th
Vernonia thorelii Gagnep., NL, Ch
Vernonia tonkinensis Gagnep., NL, Ch
Xanthium strumarium L., NL, Th
Wedelia calendulacea Less., NL, Ch
Wedelia urticaefolia DC., NL, Ch

BALANOPHORACEAE

Balanophora fungosa Forst. & Forst. f., V, Pp
 (B. *pierrei* H. Lec.)
Balanophora sp., V, Pp

BALSAMINACEAE

Impatiens bonii Hook.f., V, Ch
Impatiens chinensis L., V, Th
Impatiens claviger Hook.f., V, Ch
Impatiens aff. *verrucifer* Hook.f., V, Ch

BASELLACEAE

Basella rubra L., NL, Ch

BEGONIACEAE

Begonia sp1., V, Ch
Begonia sp2., V, Ch
Begonia sp3., V, Ch

Begonia sp4., V, Ch

Begonia sp5., V, Ch

BIGNONIACEAE

Fernandoa collignonii (Dop) Steen., V, MM
 (*Spathodeopsis collignonii* Dop)
Fernandoa sp., V, MM
Markhamia stipulata Soem., V, MM
Oroxylon indicum (L.) Vent., V, MM
Radermachera boniana Dop, V, MM
Radermachera ignea (Kurz) Steen., V, MM
 (*Mayodendron igneum* Kurz)

BIXACEAE

Bixa orellana L., NL, Mi

BOMBACACEAE

Gossampinus malabaricum (DC.) Merr., V, MM

BORAGINACEAE

Bothriospermum tenellum Fisch., V, Th
Cordia grandis Roxb., NL, Mi
Carmone microphylla (Lam.) Don, V, Na
Ehretia hanceana Hemsl., NL, Lp
Ehretia acuminata R. Br., V, Mi
Heliotropium indicum L., NL, Th
Tournefortia sarmentosa Lam., V, Lp

BRASSICACEAE

Cardamine hirsuta L. var. *silvatica* Link., NL,
 H
Rorippa indica (L.) Hiern., NL, Cr
Rorippa nasturtium-aquaticum (L.) Hayek., NL,
 Th

BUDDLEJACEAE

Buddleja asiatica Lour., NL, Na

BURSERACEAE

Bursera tonkinensis Guill., SL, MM
Canarium album Raeusch., SL, MM
Canarium subulatum Guill., SL, MM (*C. vittatistipulatum* Guill.)
Canarium tonkinense Engl., SL, MM
Canarium tramdenum Dai & Jakovl., SL, MM
Garuga pinnata Roxb., SL, MM

BUXACEAE

Buxus wallichiana Baill., SUM, Ch

CAMPANULACEAE

Codonopsis celebica (Blume) Thuan, V, Cr
Codonopsis javanica (Blume) Hook.f., V, Cr
Lobelia chinensis Lour., V, Ch
Pratia begonifolia Lindl., V, Cr

CAPPARACEAE

Capparis viburnifolia Gagnep., V, Lp
Capparis viminea Hook., V, Na
Capparis sp1., V, Lp
Capparis sp2., V, Lp

Capparis sp3., V, Lp
Cleome gynandra L., NL, Th
Cleome pentaphylla DC., NL, Th
Cleome sp., NL, Th
Crataeva magna (Lour.) DC., V, MM
Stixis ovata (Korth.) Hall. f., V, Lp

CAPRIFOLIACEAE

Lonicera dasystyla Rehder, V, Lp
Sambucus javanica Reinw. ex Blume, V, Na
Viburnum lutescens Blume, V, Mi (V.
colebrookianum Wall.)
Viburnum sp., V, Na

CARDIOPTERIDACEAE

Cardiopteris lobata Wall., V, Ch

CARICACEAE

Carica papaya L., V, PhH

CARYOPHYLLACEAE

Drymaria cordata Willd., V, Th
Malachium aquaticum Fries, NL, Ch

CECROPIACEAE

Poikilospermum suaveolens (Blume) Merr., V, Lp
(Conocephalus tonkinensis O. Renner)

CELASTRACEAE

Celastrus geinata Loesw., V, Lp
Celastrus bindsii Benth. & Hook., V, Lp
Celastrus orbiculata Merr., V, Lp
Celastrus tonkinensis Pitard, V, Lp
Celastrus sp., V, Lp
Euonymus mitratus Pierre, SUM, Mi
Euonymus aff. *nitidus* Benth., SUM, Mi
Euonymus sp., SUM, Mi
Glyptopetalum gracilipes Pierre, SUM, Na
Glyptopetalum tonkinense Pitard, SL, Na
Hippocratea indica Willd., SL, Lp
Hippocratea sp., SL, Lp

CERATOPHYLLACEAE

Ceratophyllum demersum L., NL, Cr

CHENOPODIACEAE

Chenopodium album L., NL, Th
Chenopodium ambrosioides L., NL, Th

CHLORANTHACEAE

Chloranthus brachystachys Blume, V, Na
Sarcandra glabra (Thunb.) Nakai, V, Na

CLUSIACEAE

Callophyllum balansae Pitard, SUM, MM
Callophyllum bonii Pitard, SUM, MM
Callophyllum tonkinensis Pitard, SL, Mi
Cratoxylon cochinchinensis (Lour.) Blume, NL,
 Mi (*Cratoxylon polyanthum* Korth.)
Cratoxylon formosum (Jack.) Dyer, NL, Mi

ssp. *prunifolium* (Kurz) Gagnep. (*Cratoxylon*
prunifolium Dyer.)

Cratoxylon sp., NL, Mi

Garcinia coua Roxb., V, MM

Garcinia sp1., V, MM

Garcinia sp2., SL, Mi

Hypericum japonicum Thunb., NL, Th

Hypericum sampsonii Hance, NL, Ch

COMBRETACEAE

Anogeissus acuminata (DC.) Guill. & Perr., V,
 MM (*Anogeissus tonkinensis* Gagnep.)

Combretum latifolium Blume, V, Lp (*Combretum*
extensum Roxb.)

Combretum punctatum Blume, V, Lp ssp.
squamosum (G. Don) Exell. (*Combretum*
squamosum Roxb.)

Quisqualis indica L., V, Lp

Terminalia myriocarpa Heurck & Muell., V, MM

CONNARACEAE

Cnestis palala (Lour.) Merr. ssp. *palala* Vidal,
 NL, Lp

Connarus paniculatus Roxb. var. *paniculatus*, NL,
 Lp f. *tonkinensis* Vidal

Rourea minor (Gaerth.) Leenh., NL, Lp ssp.
monadelphae (Roxb.) Vidal

CONVOLVULACEAE

Argyreia capitata (Vahl) Choisy, NL, Lp

Argyreia obtusifolia Lour., NL, Lp

Argyreia pierreana Boiss., NL, Lp

Argyreia sp., NL, Lp

Cuscuta hygrophilae Pearson, NL, Pp

Erycibe boniana Gagnep., V, Ch

Erycibe crassiuscula Gagnep., NL, Ch

Evolvulus sublobata (L.f.) Kuntze, NL, Th

Hexittia sublobata (L.f.) Kuntze, NL, Th (*H.*
bicolor Wight)

Ipomoea cairica (L.) Sweet, NL, Lp (*Ipomoea*
pulchella Roth)

Ipomoea pes-tigridis L., NL, Lp

Ipomoea pileata Roxb., NL, Lp

Ipomoea sp1., NL, Lp

Ipomoea sp2., NL, Lp

Jacquemontia paniculata (Burm.f.) Hallier f.,
 NL, Lp (*Convolvulus parviflorus* Vahl)

Lepistemon binectariferum (Wall.) Kuntze, NL,
 Th

Merremia bederacea (Burm.f.) Hallier f., NL, Lp
(Ipomoea chryseides Ker-Gawl.)

Merremia petaloides (Choisy) Burm.f., NL, Lp
(Ipomoea petaloidea Choisy)

Merremia vitifolia (Burm.f.) Hallier f., NL, Th
(Ipomoea vitifolia Sweet)

Neuropeltis maingayi Peter ex Oost., NL, Ch
(Neuropeltis racemosa Wall.)

Operculina turpethum (L.) S.Manso, NL, Lp
(*Ipomoea turpethum* R. Br.)

CRASSULACEAE

Bryophyllum calycinum Salisb., SUM, Ch

CUCURBITACEAE

Gomphogyne bonii Gagnep., V, Th
Gynopetalum cochinchinensis (Lour.) Kurz, V, Th
Gynopetalum integrifolium (Roxb.) Kurz, V, Th
(*Gynopetalum monoicum* Gagnep.)
Gynostemma pentaphylla (Thunb.) Makino, V, Th
(*Gynostemma pedata* Blume)
Gynostemma sp., V, Th
Hodgsonia macrocarpa (Blume) Cogn., V, Ch
Mukia maderaspatana (L.) Roem., V, Th
(*Melothria maderaspatana* Cogn.)
Momordica cochinchinensis (Lour.) Spreng., V, Ch
Sobena heterophylla Lour., V, Th (*Melothria heterophylla* Cogn.)
Thladiantha cordifolia (Blume) Cogn., V, Ch
(*Thladiantha calcarata* Clarke)
Thladiantha siamensis Craib, V, Ch (*Momordica tonkinensis* Gagnep.)
Trichosanthes ovigera Blume, V, Th (*T. himalensis* Clarke)
Trichosanthes lepinians Cogn., V, Th
Trichosanthes rubriflos Cayla, V, Th
Trichosanthes tricuspidata Blume, V, Th
Trichosanthes sp., NL, Th
Zehneria indica (Lour.) Kurandron, NL, Th
(*Melothria indica* Lour.)
Zehneria maysorensis (Wight & Arn.) Arn., NL, Th
(*Melothria perpusilla* Cogn.)

DATISCEAE

Tetrameles nudiflora R.Br., V, MM

DILLENIACEAE

Dillenia aurea Sw., V, MM
Dillenia pentagyna Roxb., V, MM
Dillenia turbinata Finet & Gagnep., V, MM (*D. heterosepala* Finet & Gagnep.)
Tetracera scandens (L.) Merr., NL, Lp

DIPTEROCARPACEAE

Hopea bongaiensis Tard. Blot, SUM, MM
Hopea umbellifera Gagnep., V, MM
Shorea chinensis (Wang Hsie) Zhu Hua, V, MM
(*Shorea assamica* Dyer ssp. *assamica*)
Vatica cinerea King, V, MM (*V. harmandiana* Pierre)

EBENACEAE

Diospyros bonii H. Lec., SL, MM
Diospyros eriantha Champ., SL, Mi
Diospyros mun H. Lec., SUM, MM

Diospyros pilosella H. Lec., V, Mi

Diospyros sp1., V, MM

Diospyros sp2., V, MM

Diospyros sp3., V, MM

ELAEAGNACEAE

Elaeagnus bonii H. Lec., SL, Lp
Elaeagnus conferta Roxb. var. *balansae* Serv., SL, Lp

ELAEOCARPACEAE

Elaeocarpus apiculatus Gagnep., V, MM
Elaeocarpus decurvatus Diels, V, MM
Elaeocarpus dubius A. DC., V, MM
Elaeocarpus grandiflorus Smith, SL, MM
Elaeocarpus laoticus Gagnep., V, MM
Elaeocarpus stapfianus Gagnep., V, MM
Elaeocarpus sylvestris Poir., V, MM
Elaeocarpus viguieri Gagnep., V, Mi
Sloanea sigun K. Schum., V, MM

ESCALLONIACEAE

Itea chinensis Gagnep., NL, MM
Itea cochinchinensis (Pierre) Gagnep., NL, Mi

EUPHORBIACEAE

Acalypha australis L., NL, Th
Acalypha lanceolata Willd., NL, Mi
Acalypha welkesiana Muell.-Arg., NL, Mi
Actephila excelsa Muell.-Arg., V, Mi
Actephila subsessilis Gagnep., V, Mi
Alchornea rugosa Muell.-Arg., NL, Mi
Alchornea tiliacifolia Muell.-Arg., NL, Mi
Aleurites moluccana (L.) Willd., V, MM
Antidesma ambigum Pax & Hoffm., V, Mi
Antidesma fordii Hemsl., V, MM (*Antidesma yunnanense* Pax & Hoffm.)
Antidesma ghaesambilla Gaertn., V, Mi
Antidesma hainanensis Merr., V, Mi
Antidesma montanum Blume, V, Mi
Antidesma poilanei Gagnep., V, Mi
Antidesma tonkinensis Gagnep., V, Mi
Antidesma sp1., V, Mi
Antidesma sp2., V, Mi
Antidesma sp3., V, Mi
Aporosa dioica (Roxb.) Muell.-Arg., V, MM
Aporosa sphaerosperma Gagnep., V, Mi
Aporosa sp., V, Mi
Baccaurea ramiflora Lour., V, MM (*Baccaurea sapida* Muell.-Arg.)
Baliospermum montanum (Willd.) Muell. Arg., V, Na
Bischofia javanica Blume, V, MM
Breynia angustifolia Hook.f., NL, Na
Breynia fruticosa Hook., NL, Na
Breynia indochinensis Beille, NL, Na
Breynia sp., NL, Na

- Bridella penangiana* Hook.f., V, MM
Bridelia monoica (Lour.) Merr., V, Mi (*B. tomentosa* Blume)
Bridelia poilanei Gagnep., V, Mi
Bridelia pierrei Gagnep., V, Mi
Cenestemon tonkinensis Gagnep., SL, Ch
Claoxylon indicum (Reiwn. ex Blume) Hassk., V, Mi
Cleidion brevipetiolatum Pax & Hoffm., SL, MM
Cleidion bracteosum Gagnep., SL, Mi
Cleistanthus myrianthus Kurz, SL, Mi
Croton bonianus Gagnep., SUM, Mi
Croton eberhardtii Gagnep., SUM, Mi
Croton joufra Roxb., SL, MM
Croton latsonensis Gagnep., SUM, Na
Croton tiglium L., V, Mi
Croton sp1., SL, Mi
Croton sp2., SL, Mi
Croton sp3., SL, Mi
Deutzianthus tonkinensis Gagnep., NL, MM
Drypetes perreticula Gagnep., SUM, MM
Drypetes salicifolia Gagnep., SUM, MM
Endospermum chinense Benth., V, MM
Euphorbia hirta L., NL, Th
Euphorbia hypericifolia L., NL, Th
Euphorbia pulcherrima Willd., NL, Na
Euphorbia thymifolia Burm., NL, Th
Euphorbia sp1., NL, Ch
Euphorbia sp2., NL, Ch
Excoecaria cochinchinensis (Lour.) Kuntze, V, Na
Glochidion gamblei Hook., V, Mi
Glochidion eriocarpum Champ., NL, Na
Glochidion hirsutum Muell.- Arg., NL, MM
Glochidion manogynum Hook., NL, Mi
Glochidion zeylanicum A. Juss., NL, Mi
Glochidion sp., NL, Na
Hura crepitans L., NL, MM
Jatropha curcas L., NL, Na
Macaranga denticulata (Blume) Muell.- Arg., NL, MM
Macaranga sp., NL, Mi
Mallotus apelta Muell.- Arg., NL, Mi
Mallotus barbatus Muell.- Arg., NL, Mi
Mallotus cuneatus Ridley, NL, Na
Mallotus hookerianus Muell.- Arg., V, MM
Mallotus lanceolatus (Gagnep.) Airy Shaw., SL, Na
Mallotus macrostachyus (Miq.) Muell.- Arg., SL, Mi
Mallotus paniculatus (Lam.) Muell.- Arg., NL, Mi (*M. cochinchinensis* Lour.)
Mallotus philippinensis (Lam.) Muell.- Arg., SL, Mi
Mallotus sp., V, Mi
Microdesmis casaeriaefolia Planch., NL, MM
Phyllanthus emblica L., V, Mi
Phyllanthus niruri L., NL, Th
Phyllanthus poilanei Beille., SL, Mi
Phyllanthus pseudoreticulatus Thin, NL, Na
Phyllanthus reticulatus Poir., NL, Lp
Phyllanthus simplex Retz., NL, Th
Phyllanthus urinaria L., NL, Th
Phyllanthus sp1., NL, Th
Phyllanthus sp2., NL, Th
Ricinus communis L., NL, Mi
Sapium discolor (Champ.) Muell.-Arg., NL, Mi
Sapium indicum Willd., V, MM
Sapium sebiferum Roxb., V, MM
Sauropus androgynus (L.) Merr., SL, MM
Sauropus macranthus Hassk., SL, Mi
Sauropus natchauensis Thin. V. Na
Sauropus spectabilis Miq., SL, Na
Sauropus racemosus Beille., V, Mi
Strophoblachia glandulosa Pax & Hoffm., SL, Mi
Sumbaviopsis albicans J.J. Sm. var. *disperma* Gagnep., SL, Mi
Trigonostemon bonianus Gagnep., NL, Ch
Trigonostemon eberhardtii Gagnep., SL, Mi
Trigonostemon flavidus Gagnep., SL, Mi
Trigonostemon stellaris (Gagnep.) Airy Shaw, V, Mi
Vernicia montana Lour., V, Mi
- FABACEAE**
- Acacia confusa* Merr., NL, MM
Acacia intsia (L.) Willd., NL, Lp
Acacia pennata (L.) Willd., V, Lp
Adenanthera pavonina L., V, MM (*A. microsperma* Teysm. & Binn.)
Aeschynomene indica L., NL, H
Albizia kalkora Prain, NL, Mi
Albizia lebbek (L.) Benth., SUM, MM
Albizia lucidior (Steud.) I. Nielsen, V, MM (*A. lucida* Benth.)
Albizia sp1., V, MM
Albizia sp2., V, MM
Albizia sp3., V, Mi
Alysicarpus vaginalis (L.) DC., SUM, Ch ssp. *cucphuongensis* Khoi
Archidendron clypearia (Jacks.) I. Nielsen, SL, MM (*Pithecellobium clypearia* Benth.)
Archidendron sp1., V, MM
Archidendron sp2., V, Mi
Atylosia scarabaeoides (L.) Benth., NL, Lp
Bauhinia championii (Benth.) Benth., SL, Na (*B. lecomtei* Gagnep.)
Bauhinia touranensis Gagnep., V, Lp
Bauhinia viridescens Desv., SL, Na
Bauhinia sp1., SL, Lp

Bauhinia sp2., SL, Lp
Bourgingia callicarpa Champ., V, Lp
Cajanus cajan (L.) Millsp., NL, Na (*C. indicus* Spreng.)
Caesalpinia culculata Roxb., V, Lp (*Mezoneuron cucullatum* Wight. & Arn.)
Caesalpinia latisiliqua (Cav.) Hattinko, V, Lp (*Mezoneuron balansae* Prain)
Caesalpinia minax Hance, V, Lp
Caesalpinia nuga Ait., SL, Lp
Caesalpinia sappan L., V, MM
Canavalia cathartica Du Petit-Thouars, V, Lp (*C. turgida* Grah. ex Gray)
Canavalia ensiformis (L.) DC., V, Lp
Cassia hirsuta L., NL, Th
Cassia mimosoides L., NL, Ch
Cassia occidentalis L., NL, Ch
Cassia tora L., NL, Th
Crotalaria albida Heyne, NL, H
Crotalaria ferruginea Grah., NL, Ch
Crotalaria juncea L., NL, Na
Crotalaria linifolia L.f. var. *linifolia*, NL, Th var. *angustifolia* Gagnep.
Crotalaria sessiliflora L., NL, Ch
Crotalaria striata DC., NL, Na (*M. mucronata* Desv.)
Crotalaria verrucosa L., NL, Na
Dalbergia balansae Prain, V, MM
Dalbergia lanceolaria L.f., V, MM
Dalbergia rimosa Roxb., V, Na
Delonix regia Raf., NL, MM (*Poinciana regia* Bojer ex DC.)
Derris albo-rubra Hemsley, SL, Na
Derris elleptica Benth., SL, Lp
Derris tonkinensis Gagnep., SL, Lp
Derris wallichiana Prain, SL, Lp
Derris sp., SL, Na
Desmodium cephalotes Wall., NL, Na
Desmodium elegans (Lour.) Benth., NL, Ch
Desmodium gangeticum (Lour.) DC., NL, Ch
Desmodium gyrans DC., NL, Ch
Desmodium gyroides DC., NL, Na
Desmodium heterocarpum (L.) DC., NL, Lp
Desmodium heterophyllum (Willd.) DC., NL, Ch
Desmodium lasiocarpum (P. Beauv.) DC., NL, Ch
Desmodium latifolium DC. var. *virgatum* Miq., NL, Na
Desmodium laxiflorum DC., NL, Ch
Desmodium polycarpum (Lam.) DC., NL, Ch
Desmodium pulchellum (L.) Benth., NL, Ch
Desmodium triquetrum (L.) DC., NL, Ch
Dolichos sp., NL, Th
Entada phaseoloides (L.) Merr., V, Lp (*E. tonkinensis* Gagnep.)
Erythrina stricta Roxb., V, MM

Erythrophloeum fordii Oliv., V, MM
Flemingia congesta Roxb., NL, Na
Galactia longipes Gagnep., V, Lp (*G. mouretii* Gagnep.)
Gleditschia pachycarpa Bala, V, MM
Indigofera galeoides DC., V, Na
Indigofera hirsuta L., V, Ch
Indigofera trifoliata L., NL, Ch
Indigofera sp., NL, Mi
Lepedeza sericea Miq., SUM, Na
Leucaena leucocephala (Lam.) De Wit, NL, Mi (*L. glauca* (Willd.) Benth.)
Milletia aff. *dielsiana* Harms ex Diels, SL, Lp
Milletia ichthyochtona Drake, SL, MM
Milletia pachyloba Drake, NL, Lp
Milletia pulchra Kurz, NL, Na
Milletia sp1., V, MM
Milletia sp2., V, Mi
Milletia sp3., V, Lp
Mimosa invisa Mart.ex Colla, V, Ch
Mimosa pudica L., V, Ch
Mucuna hainanensis Hayta, V, Lp
Ormosia hainanensis Gagnep., SL, MM
Ormosia tonkinensis Gagnep., SL, Mi
Peltophorum dasyrrhachis (Miq.) Kurz var. *tonkinensis* (Pierre) K. & S.S. Larsen, V, MM (*P. tonkinense* Gagnep.)
Pterolobium microphyllum Miq., V, Lp (*P. platypterum* Gagnep.)
Saraca dives Pierre, V, Mi
Psophocarpus tetragonolobus (L.) DC., NL, Th
Pueraria thomsonii Benth., NL, Lp
Pueraria montana (Lour.) Merr., NL, Lp (*P. tonkinensis* Gagnep.)
Sesbania sp., NL, Ch
Smitia sensitiva Ait., V, Ch
Tephrosia aff. *kerrii* Drumm. & Craib, NL, Na
Tephrosia purpurea (L.) Pers, NL, Ch
Uraria crinita (L.) Desv., NL, Ch
Uraria lagopoides DC., NL, H
Uraria macrostachya Wall., NL, Ch
Uraria rufescens (DC.) Schindl., NL, H (*U. hamosa* Wall.)
Vigna radiata (L.) Wilczek var. *sublobata* (Roxb.) Verdcourt, NL, Lp (*Phaseolus sublobatus* Roxb.)
Vigna umbellata (Thunb.) Ohwi & Ohashi, NL, Lp (*Phaseolus calcaratus* Roxb.)
Vigna sp1., NL, Lp
Vigna sp2., NL, Lp

FAGACEAE

Castanopsis indica A.DC., V, MM
Castanopsis lecomtei Hickel & A. Camus, V, MM
Castanopsis symmetriculata Luong, SL, MM

- Lithocarpus areca* Hickel & A. Camus, SL, MM
Lithocarpus corneus (Lour.) Rehd., V, MM
Lithocarpus pseudosundaica Hickel & A. Camus, NL, Mi
Lithocarpus aff. *stenopus* Hickel & A. Camus, NL, MM
Lithocarpus aff. *thomsonii* Hickel & A. Camus, SL, MM
Lithocarpus sp1., SL, MM
Lithocarpus sp2., SUM, MM
Quercus aff. *dussaudii* Hickel & A. Camus, SUM, MM
Quercus sp., SUM, Mi

FLACOURTIACEAE

- Casearia sequilateralis* Merr., V, Mi
Flacourtia balansae Gagnep., V, Mi
Flacourtia ratmonchii L'Herit., V, MM
Homanlium paniculiflorum How & Ko, V, Mi
Homalium sp., V, Mi
Hydnocarpus hainanensis (Merr.) Sleum., V, MM
Hydnocarpus kurzii (King) Warb., V, MM ssp. *australis* Sleum.
Taractogenos sp., V, MM
Scolopia chinensis Clos., V, Na

GENTIANACEAE

- Exacum tetragonum* Roxb., V, Ch
Fagraea ceilanica Thunb., V, Lp (*F. obovata* Wall.)

GESNERIACEAE

- Boea martini* Lévl., SL, Na
Boea umbellata Drake, SL, Ch
Chirita balansae Drake, SL, H
Chirita hamoea R. Br., SL, Ch
Chlamydofoea sinensis (Oliv.) Stapf, var. *macrophylla*, SL, Ch
Didymecarpus sp., V, Ch
Didissandra aspera Drake, V, Na
Didissandra sp., V, Ch
Rhynchothecum parviflorum Blume, V, Ch

HAMAMELIDACEAE

- Liquidambar formosana* Hance, NL, MM

HERNANDIACEAE

- Illigera celebica* Miq., V, Lp (*I. platyandra* Dunn.)
Illigera rhodantha Hance var. *rhodantha*, V, Lp var. *dunniana* (Levl.) Kubitzki (*Illigera glandulosa* Gagnep.)

HIPPOCASTANACEAE

- Aesculus assamica* F. Griff., NL, Mi

HYDRANGEACEAE

- Dicbroa hirsuta* Gagnep., V, Na

HYDROPHYLLACEAE

- Hydrolea zeylanica* Vahl, V, Th

ICACINACEAE

- Gomphandra oppsitifolia* Pierre, V, Na
Iodes cirrhosa Turcz, V, H (*I. ovalis* Blume)
Iodes sp., V, H
Nothapodytes pittosporoides (Oliv.) Sleum., V, Mi
Nothapodytes sp., V, Mi

ILliciACEAE

- Illicium griffithii* Hook. var. *cambodianum* Finet & Gagnep., SUM, MM

JUGLANDACEAE

- Annamocarya chinensis* Dode, V, MM
Engelhardtia spicata Blume, V, MM
Platycarya strobilacea Sieb. & Zucc., SUM, MM
Pterocarya tonkinensis Dode, V, MM

LAMIACEAE

- Ajuga decumbens* Thunb., V, Ch
Alisomoles indica (L.) Kuntze, V, Th (*A. ovata* R. Br.)
Gomphostemma leptodon Dunn, V, Ch
Gomphostemma lucidum Wall. & Benth., V, Ch
Leonurus artemisia (Lour.) S.Y.Hu, NL, Ch (*L. heterophyllus* Sw.)
Leucas mollissima Wall. ex Benth., V, Ch
Leucas zeylanica (L.) R. Br., NL, Ch
Mentha arvensis L., NL, H
Mentha aquatica L., NL, H
Microtoena insuavis (Hance) Dunn, NL, Th
Mosla cavaleriei Levl., V, Th
Ocimum basilicum L., NL, Th
Ocimum sanctum L., NL, Th
Orthosiphon thymiflorus (Roth) Slecsiin, V, Ch (*O. tomentosus* Benth.)
Paraphlomis javanica (Blume) Prain, V, Ch (*P. rugosa* Prain)
Perilla frutescens (L.) Britt., NL, Th
Plectranthus ternifolius D. Don, NL, Na
Pogostemon auricularius (L.) Hassk., V, Th
Salvia plebeia R. Br., V, Th
Salvia splendens Ker. Gowl., NL, Th
Stachys oblongifolia Wall. ex Benth., V, H
Teucrium viscidum Blume, V, H (*T. stoloniferum* Roxb.)

LAURACEAE

- Actinodaphne pilosa* (Lour.) Merr., V, MM
Beilschmiedia aff. *erythroploia* Hayata, V, MM
Beilschmiedia fordii Dunn., V, MM
Beilschmiedia ferruginea H. Liu, V, MM
Beilschmiedia laevis Allen, V, MM
Beilschmiedia obovalifolia Lecomte, V, MM
Beilschmiedia robusta Allen, V, MM

Beilschmiedia roxburghiana Nees, V, MM
Beilschmiedia sp1., SL, MM
Beilschmiedia sp2., V, MM
Beilschmiedia sp3., V, MM
Beilschmiedia sp4., V, MM
Caryodaphnopsis aff. *baviensis* (Lecomte) Airy Shaw, V, MM (*Nothaphoebe* aff. *baviensis* Lecomte)
Caryodaphnopsis tonkinensis (Lecomte) Airy Shaw, V, MM (*Nothaphoebe tonkinensis* Lecomte)
Cassytha filiformis L., NL, Pp
Cinnamomum balansae Lecomte, V, MM
Cinnamomum bejolghota (Buch.- Ham.) Sweet, V, MM (*C. obtusifolium* Nees)
Cinnamomum bonii Lecomte, V, MM
Cinnamomum cambodiamum Lecomte, SL, MM
Cinnamomum camphora Sieb., NL, MM
Cinnamomum curvifolium (Lour.) Kosterm., V, MM (*C. albiflorum* Nees)
Cinnamomum polyadelphum (Lour.) Kosterm., V, MM (*C. litseaefolium* Thw.)
Cinnamomum tetragonum A. Chev., V, MM
Cinnamomum validinerve Hance, V, MM
Cryptocarya impressa Miq., V, MM
Cryptocarya lenticellata Lecomte, V, MM
Cryptocarya oblongifolia Blume, V, MM
Cryptocarya sp., V, MM
Lindera balansae Lecomte, V, MM
Lindera polyantha Boerl., V, MM
Lindera tonkinensis Lecomte, V, Mi
Litsea baviensis Lecomte, V, Na
Litsea cubeba Pers., SL, Mi
Litsea glutinosa (Lour.) L. Rob., SL, Mi
Litsea hefferi Hook., V, Na
Litsea mollifolia Chun., V, Mi (*L. mollis* Hemsl.)
Litsea monopetala Roxb., V, MM
Litsea panamonja (Nees) Hook.f., V, Mi
Litsea rotundifolia Hemsl., V, Na
Litsea umbellata (Lour.) Merr., V, Mi (*L. amara* Blume)
Litsea verticillata Hance, V, MM
Litsea sp1., V, Mi
Litsea sp2., V, Na
Machilus bombycina King, V, Mi
Machilus hainanensis Merr., V, MM
Machilus odoratissima Nees, V, MM
Machilus platycarpa Chun, V, Mi
Machilus thunbergii Sieb. & Zucc., V, MM
Machilus sp., V, MM
Neocinnamomum caudatum (Nees), V, Mi (*N. poilanei* H.Liu)
Neocinnamomum delavayi (Lecomte) H.Liu, V, Na (*N. parvifolium* (Lecomte) H.Liu)
Neocinnamomum lecomtei H.Liu, V, Mi

Neolitsea zeylanica Merr., V, Mi
Phoebe tavogana (Meissn.) Hook.f., V, MM (*P. cuneata* Blume)

LECYTHIDACEAE

Barringtonia eberhardtii Gagnep., V, MM
Barringtonia edaphocarpa Gagnep., V, Mi

LEEACEAE

Leea guineensis G. Don, V, Na (*L. acuminata* Wall.)

LINACEAE

Tirpitzia chinensis (Hemsl.) Hall., SL, Mi

LOGANIACEAE

Strychnos wallichiana Steud.ex DC., V, Lp (*S. gaulthierana* Pierre)

LORANTHACEAE

Elytranthe ampullacea G. Don, V, Pp
Loranthus adpressus Lecomte, V, Pp
Loranthus pentandrus L., V, Pp
Loranthus ferrugineus Roxb., V, Pp
Loranthus scurrulla L., V, Pp
Taxillus chinensis (DC.) Dans., V, Pp
Taxillus estipitatus (Stapf.) Dans., V, Pp

LYTHRACEAE

Ammaria auriculata Willd. var. *arenaria* Kochne, NL, Ch
Ammaria baccifera L., NL, Th
Duabanga grandiflora (Roxb. ex DC.) Walp., V, MM
Lagerstroemia corniculata Gagnep., SL, Mi
Rotala rotundifolia Kochne., NL, H

MAGNOLIACEAE

Magnolia eriostepta Dandy, SL, Mi
Manglietia conifera Dandy, V, MM
Michelia balansae Dandy, V, MM
Michelia chapaensis Dandy, SL, Mi

MALPIGHIACEAE

Aspidopteria aff. *glabrifolia* J. Ar., V, Lp
Aspidopteris obcordata Hemsl., V, Lp
Hiptage boniana P. Dop, V, Lp
Hiptage benghalensis (L.) Kurz, V, Lp
Hiptage sp., V, Lp

MALVACEAE

Abutilon indicum G. Don, NL, Ch
Hibiscus abelmoschus L., V, Na
Hibiscus mutabilis L., NL, Na
Hibiscus rosa-sinensis L., NL, Mi
Kydia calycina Roxb., V, MM
Sida acuta Burm., V, Na
Sida rhombifolia L., V, Na
Urena lobata L., V, Na

MELASTOMATACEAE

- Blastus cochinchinensis* Lour., V, Na
Blastus multiflorus (Cogn.) Guill., V, Na
Melastoma candidum D. Don, NL, Na
Melastoma normale D. Don, NL, Ch
Melastoma sanguineum Sims, V, Na (*M. decemfidum* Roxb.)
Melastoma trungii Pocs. & Tiep, V, Na
Osbeckia truncata D. Don, V, H

MELIACEAE

- Aglaia gigantea* (Pierre) Pellegr., V, MM
Aglaia odorata Lour., V, Mi
Aglaia tetrapetala Pierre, V, MM
Amoora aphanamixis Roem. & Schult., V, Mi
 (*Aglaia aphanamixis* Pellegr. var. *frutescens* C. DC.)
Amoora aff. *cucullata* Roxb., V, MM
Amoora sp., V, Mi
Chisocheton globosus Pierre, V, MM
Chisocheton paniculatus Hiern., V, MM
Chukrasia tabularis A. Juss., V, MM
Cipadessa fruticosa Blume, V, Mi
Dysoxylon binectariferum Hook.f., V, MM
Dysoxylon cauliflorum Hiern., V, MM
Dysoxylon aff. *cochinchinensis* Pierre, V, MM
Heynia trijuga Roxb., V, MM
Melia azedarach L., V, MM
Toona sureni (Blume) Moore, V, MM
Walsura bonii Pellegr., V, MM

MENISPERMACEAE

- Cissampelos pareira* L., V, Lp
Cyclea tonkinensis Gagnep., V, Lp
Cocculus laurifolius DC., V, Ch
Diploclisia macrocarpa Miers, V, Lp
Fibraurea recisa Pierre, V, Lp
Parabaena sagittata Miers, V, Ch
Tinomiscum tonkinensis Gagnep., V, Lp
Stephania bernandifolia Spreng., V, Lp
Stephania rotunda Lour., SL, Cr

MORACEAE

- Antiaris toxicaria* Leschen., V, MM
Artocarpus heterophyllus Lam., NL, MM
Artocarpus parva Gagnep., V, Mi
Artocarpus petelotii Gagnep., V, MM
Artocarpus tonkinensis A. Chev., V, MM
Broussonetia kazinoki Sieb., V, Ch
Broussonetia papyrifera Vent., V, Mi
Maclura cochinchinensis (Lour.) Corner, V, Lp
 (*Cudrania cochinchinensis* Lour., *C. javanensis* Trecul)
Dimerocarpus brennieri Gagnep., V, MM
Ficus altissima Blume, SL, MM
Ficus annulata Blume, SL, MM

- Ficus auricula* Lour., V, Mi (*F. roxburghii* Wall.)
Ficus benjamina L., SL, MM
Ficus callosa Willd., SL, MM
Ficus callophylloides Blume, V, MM
Ficus capillipes Gagnep., V, Mi
Ficus chaffansjoni Lev., V, Lp
Ficus cunta Hamilt., V, Mi
Ficus curtipes Corner., V, MM
Ficus dumosa King, V, Na
Ficus fistulosa Reinw. ex Blume, V, MM (*F. barlandii* Benth.)
Ficus fulva Reinw. ex Blume var. *fulva*, V, Mi
 var. *minor* King.
Ficus gibbosa Blume, V, MM
Ficus glaberrima Blume, V, Mi
Ficus glandulifera Wall., V, Mi
Ficus heterophylla L., V, Na
Ficus hirta Vahl, NL, Na
Ficus hispida L., V, Mi
Ficus lacor Hamilt., V, MM (*F. infectoria* Roxb.)
Ficus laevis Blume, V, Lp
Ficus lamponga Miq., V, Mi (*F. balansae* Gagnep.)
Ficus leckensis Drake, V, Na
Ficus nervosa Heyne, V, MM
Ficus obscura Blume, V, Mi
Ficus pilosa Reinw., V, MM
Ficus pumila L., V, Lp
Ficus racemosa L., V, MM (*F. glomerata* L. var. *chittagonta* King)
Ficus religiosa L., NL, MM
Ficus retusa L., V, MM
Ficus rostrata Lam., V, Na
Ficus sagittata Vahl, V, Lp (*F. ramentacea* Roxb.)
Ficus sikkimensis Miq., V, Lp
Ficus sum Gagnep., V, Mi
Ficus superba Miq., V, MM
Ficus variegata Blume, V, Mi
Ficus sp1., V, Lp
Ficus sp2., V, MM
Malaisia scandens (Lour.) Planch., V, Ch (*M. tortuosa* Blume var. *scandens* Bur.)
Morus alba L., NL, Mi
Streblus asper Lour., NL, Mi
Streblus ilicifolia (Kurz) Corner, SL, Na
 (*Txotrophis ilicifolia* (Kurz) Vidal)
Streblus taxoides (Heyne) Kurz, SL, Na
 (*Phyllochlamys tridentata* Gagnep.)
Taxotrophis macrophylla (Blume) Merr., SL, Mi
Streblus tonkinensis (Eberh. & Dub.) Corner SL, Mi
 (*Teonongia tonkinensis* Stapf.)

MYRISTICACEAE

- Horsfieldia prainii* Warbg., V, MM
Horsfieldia tonkinensis Lecomte, V, MM

Knema conferta (King) Warbg., V, MM
Knema globularia (Lam.) Warb., V, MM
 (*K. corticosa* Lour.)

MYRSINACEAE

Ardisia maculosa Mez, V, Na
Ardisia gigantifolia Stapf., V, Na
Ardisia quinquegona Blume, V, Na
Ardisia ramondiaeformis Pitard, V, Na
Ardisia silvestri Pitard, V, Na
Ardisia tonkinensis A. DC., V, Na
Ardisia sp1., V, Na
Ardisia sp2., V, Na
Ardisia sp3., V, Na
Ardisia sp4., V, Na
Ardisia sp5., V, Na
Ardisia sp6., V, Na
Ardisia sp7., V, Na
Ardisia sp8., V, Na
Ardisia sp9., V, Na
Embelia laeta L., NL, Lp
Embelia oblongifolia Hemsl., SL, Lp
Embelia ribes Burm., NL, Lp
Embelia scandens Mez, SUM, Lp
Embelia sp1., V, Lp
Embelia sp2., V, Lp
Maesa balansae Mez, V, Na
Maesa indica (Roxb.) A.DC., V, Na
Maesa japonica (Thunb.) Mez, V, Na
Maesa striata Mez var. *opaca* Pitard, V, Na
Masea tenera Mez, V, Na
Maesa tomentella Mez, V, Na
Maesa tonkinensis Mez var. *tonkinensis*, V, Na
 var. *bonii* Pitard

MYRTACEAE

Decaspermum paniculatum Kurz, V, Mi
Psidium guajava L., V, Mi
Rhodomyrtus tomentosa Wight, NL, Na
Syzygium baviense (Gagnep.) Merr. & Perry, V,
 Mi (*Eugenia baviensis* Gagnep.)
Syzygium chlorantha (Duthie) Merr. & Perry, V,
 Mi (*Eugenia chlorantha* Duthie)
Syzygium eburneum (Gagnep.) Merr. & Perry,
 V, Na (*Eugenia eburnea* Gagnep., *Eugenia*
ebunianum Merr. & Perry)
Syzygium jambos (L.) Ast., NL, Mi (*Eugenia*
jambos L.)
Syzygium malayanum (Gagnep.) Merr. & Perry,
 V, Mi (*Eugenia malayana* Gagnep.)
Syzygium mekongense (Gagnep.) Merr. & Perry,
 V, Mi (*Eugenia mekongense* Gagnep.)
Syzygium samarangense (Blume) Merr. & Perry,
 NL, Mi (*Syzygium javanica* Lam.)
Syzygium ternifolium (Roxb.) Merr. & Perry, V,
 Mi (*Syzygium formosa* Wall. var. *ternifolia*
 Gagnep.)

Syzygium tonkinense (Gagnep.) Merr. & Perry,
 V, MM (*Eugenia tonkinensis* Gagnep.)
Syzygium zimmermannii (Warb.) Merr. & Perry,
 V, Na (*Eugenia jimerani* Warb.)

Syzygium sp1., V, MM

Syzygium sp2., V, MM

Syzygium sp3., V, Mi

OLACACEAE

Erythralium scandens Blume, V, Lp

OLEACEAE

Jasminum adenophyllum Wall., V, Lp
Jasminum lanceolarium Roxb., SUM, Lp
Jasminum longisetum Gagnep., V, Lp
Jasminum microcalyx Hance, V, Lp
Jasminum subtriplinerre Blume, V, Na
Jasminum undulatum Ker-Gawl., V, Lp

ONAGRACEAE

Ludwigia adnascens (L.) Hara, NL, H (*Jussiaea*
repens L.)
Ludwigia prostrata Roxb., NL, H (*Jussiaea*
prostrata (Roxb.) Lév.
Ludwigia octovalis (Jacq.) Raven ssp. *sessiliflora*
 (Michx.) Raven., NL, Th (*Jussiaea suffruticosa*
 L.)

OPILIACEAE

Lepionurus sylvestris Blume, SL, Na
Melanthia suavis Pierre, SL, Mi

OXALIDACEAE

Averrhoa carambola L., NL, Mi
Biophytum sensitivum DC., NL, H
Oxalis corniculata L., NL, H

PASSIFLORACEAE

Adania chevalieri Gagnep., V, Ch
Passiflora foetida L., NL, Ch
Passiflora siamica Craib, V, Ch (*P. octandra*
 Gagnep.)

PEDALIACEAE

Sesamum orientale L., NL, Th

PENTHORACEAE

Penthorum sedoides L., NL, H

PIPERACEAE

Peperomia leptostachya Hook. & Arn., V, H
Piper betle L., NL, Ch
Piper bonii DC., V, Ch
Piper gymnostachyum DC., V, Ch
Piper hainanense Hemsl., V, H
Piper lappaceum DC., V, Ch
Piper lolot DC., V, Ch
Piper longum L., V, Ch
Piper pendulipicum C. DC., V, Ch
Piper retrofractum Vahl, V, Ch

PITTOSPORACEAE

Pittosporum tonkinensis Gagnep., V, Mi

PLANTAGINACEAE

Plantago major L., NL, Cr

PLUMBAGINACEAE

Plumbago zeylanica L., NL, Ch

POLYGALACEAE

Polygala glomerata Lour., V, Na

Polygala tonkinensis Chodat, V, Na

POLYGONACEAE

Eragrostis cymosum (Trev.) Meisn., V, Ch

Polygonum barbatum L., NL, H

Polygonum chinense L., NL, H

Polygonum donii Meisn., V, Th

Polygonum flaccidum Roxb., V, H

Polygonum hydropiper L., V, H

Polygonum lapathifolium Ait., V, Th

Polygonum minus Huds., NL, H (*P. posumbu* Wall.)

Polygonum odoratum Lour., NL, Th

Polygonum orientale L., V, Th

Polygonum perfoliatum L., V, H

Polygonum plebejum R.Br., V, H

Polygonum tinctorium Lour., V, Th

Rumex wallichii Meisn., NL, Th

PORTULACACEAE

Portulaca oleracea L., NL, Th

PRIMULACEAE

Androsace saxifragifolia Bge., V, Th

Lysimachia candida Lindl., V, Ch

Lysimachia sp1., V, Ch

Lysimachia sp2., V, Ch

Lysimachia sp3., V, Ch

Lysimachia sp4., V, Ch

PROTEACEAE

Helicia cochinchinensis Lour., V, Mi

Helicia aff. *erratica* Hook., V, Mi

Heliciopsis lobata (Merr.) Skum., V, Mi

RANUNCULACEAE

Clematis armandi Fanch., V, Lp

Clematis meyniana Walp., V, Ch

Clematis smilacifolia Walp., V, Ch

Clematis umbellifera Gagnep., V, Lp

Clematis uncinata Champ., V, Lp

Ranunculus japonicus Langsd., V, Ch

Ranunculus scleratus L., V, Th

RHAMNACEAE

Berchemia lineata DC., NL, Lp

Chaydaia tonkinensis Pitard, V, Mi

Gouania leptostachya DC., V, Lp

Rhamnus tonkinensis Pitard, V, Na

Sageretia theezans Brongn., NL, Lp

Ventilago calyculata Tul. var. *macrantha* Pitard, V, Lp

Ventilago leiocarpa Benth., V, Lp

Ventilago pauciflora Pitard, V, Lp

Zizyphus mauritiana Lam., V, Na

Zizyphus oenoplia Mill., V, Mi

Zizyphus sp., V, MM

RHIZOPHORACEAE

Carallia brachiata (Lour.) Merr., V, MM (*C. lucida* Roxb.)

Carallia lancaefolia Roxb., V, Mi

ROSACEAE

Duchesnea indica (Andr.) Focke, V, Ch

Eriobotrya bengalensis (Roxb.) Hook.f., V, MM

Eriobotrya japonica (Thunb.) Lindl., V, MM

Fragaria indica L., V, H

Persica vulgaris Mill., V, Mi

Photinia benthamiana Hance, V, Mi

Prunus mume Sieb. & Zucc. V, Mi

Prunus salicina Lindl., V, Mi

Prunus zippeliana Miq., V, MM (*P. macrophylla* Sieb. & Zucc.)

Pygeum sp1., SL, MM

Pygeum sp2., SL, MM

Pyrus sp., SUM, MM

Raphiolepis indica (L.) Lindl. ex Ker, V, Na

Rosa cymosa Tratt., NL, Na (*R. microcarpa* Lindl.)

Rubus alcaefolius Poir., V, Lp

Rubus cochinchinensis Tratt., V, Lp

Rubus leucanthus Hance, V, Lp

Rubus triphyllus Thunb., V, Ch

RUBIACEAE

Adina piluliflora (Lam.) Franch. ex Drake, V, Mi
(*A. globiflora* Salisb. var. *tonkinensis* Pitard)

Aidia cochinchinensis Lour., S, UM, Mi

Anthocephalus indicus A. Rich. var. *macrophylla* Pierre, V, MM

Canthium dicoccum (Gaertn.) Tinn. & Binn, SUM, MM

Canthium sp., V, Na

Cephalanthus sp., V, Ch

Chasalia curiflora (Wall. ex Roxb.) Thw., V, Na

Diplospora sp., V, MM

Duporrea pavettaefolia Pitard, V, Na

Gardenia coronaria Ham., V, Na

Gardenia florida L., V, H

Geophila reniformis G. Don, V, Th

Hedyotis capitellata Wall. ex G. Don, V, MM

Hedyotis corymbosa (L.) Lam., NL, Na

Hedyotis multiglomerulata (Pitard) Tran, V, Na

Hymenodactylon excelsum Wall. var. *velutinum* Pierre., V, MM

Ixora diversifolia Wall. var. *flexilis* Pitard, V, Na
Ixora finlaysoniana Wall., V, Mi
Ixora henryi Lev., V, Na
Ixora sp1., V, Na
Ixora sp2., V, Na
Lasianthus andamanicus Hook., V, Mi
Lasianthus cyanocarpus Jack., V, Na
Lasianthus wallichii Wight, V, Mi
Lasianthus sp1., V, Na
Lasianthus sp2., V, Na
Lasianthus sp3., NL, Na
Morinda umbellata L. var. *tonkinensis* Pitard, V,
Lp
Morinda villosa Hook., V, Lp
Morinda sp., V, Lp
Mussaenda cambodiana Pierre, V, Lp
Mussaenda debiscens Craib, V, Mi
Mussaenda sp1., V, Lp
Mussaenda sp2., V, Lp
Mycetia longifolia Kuntze, V, Na
Myrioneuron tonkinensis Pitard, V, Na
Myrioneuron sp., V, Th
Nauclea sp., V, MM
Neonauclea sessilifolia (Roxb.) Merr., V, MM
(*Adina sessiliflora* Hook.)
Oldenlandia sp1., V, Th
Oldenlandia sp2., V, Ch
Oldenlandia sp3., V, Ch
Oldenlandia sp4., V, Ch
Ophiorrhiza annamica Pitard, V, Th
Ophiorrhiza aff. *baviensis* Drake, V, Ch
Ophiorrhiza aff. *tristis* Drake, V, Th
Ophiorrhiza sp1., V, Ch
Ophiorrhiza sp2., V, Th
Paederia scandens (Lour.) Merr. var. *tomentosa*
(Blume) Hand.-Mazz., V, Lp
Paederia sp1., V, Th
Paederia sp2., V, Th
Pavetta indica L. var. *indica* Hook., V, Na
Psychotria baviensis Pitard, V, Ch
Psychotria rubra (Lour.) Poir., V, Na
Psychotria sp1., V, Na
Psychotria sp2., V, Na
Psychotria sp3., V, Na
Psychotria sp4., V, Na
Randia acuminatissima Merr., V, MM
Randia spinosa (Thunb.) Poir., V, Na
Randia stenantha Drake, SUM, Na
Randia sp1., V, Mi
Randia sp2., V, Mi
Silvianthus bracteatus Hook., V, Na
Tarenna attenuata (Voight) Hutch., V, Na
Tarenna collinsae Craib, V, Na
Tarenna quosensis Pierre & Pitard, V, Na
Tarenna vanpruckii Craib, V, Na

Tarenna sp1., V, Na
Tarenna sp2., V, Na
Tarenna sp3., V, Na
Uncaria macrophylla Wall., V, Lp
Uncaria sessilifructus Roxb., V, Lp
Uncaria tonkinensis Haval., V, Lp
Urophyllum sp., V, Na
Xantonea quosensis Pierre, V, Mi
Xantonea sp., V, Mi
Wendlandia glabrata DC., V, Mi
Wendlandia paniculata DC., V, Mi

RUTACEAE

Acronychia pedunculata Roxb., V, MM
Atalantia guillauminii Swingle, SL, Mi
Atalantia monophylla Correa, V, Mi (*A.*
roxburghiana Hook.)
Atalantia roxburghiana Hook.f., V, Mi
Citrus lemon (L.) Burm. f., V, Na
Citrus maxima (Burm. f.) Merr., V, Mi (*C.*
grandis Osbeck)
Citrus sinensis Osbeck, V, Mi
Clausena dunniana Levl., V, Mi
Clausena excavata Burm., SL, Mi
Clausena harmandiana Pierre ex Guill., V, Mi
Clausena laevis Drake, V, Na
Clausena lansium Skeels, V, Mi (*Clausena wampi*
(Blanco) Oliv.)
Euodia fraxinifolia (Benth.) Hook., SL, MM
Euodia leptota (Spreng.) Merr., V, Mi (*E. triphylla*
DC.)
Euodia meliaefolia Benth., V, Mi
Glycosmis citrifolia Lindl., V, Mi
Glycosmis aff. *craibii* Tanaka, V, Mi
Glycosmis pentaphylla Correa, V, Mi
Glycosmis petelotii Guill., V, Mi
Glycosmis puberula Lindl. ex Wall., V, Mi
Glycosmis aff. *trichanthera* Guill., V, Mi
Glycosmis winitii Craib, V, Mi
Micromelum falcatum Tanaka, V, Mi
Micromelum hirsutum Oliv., V, Mi
Murraya koenigii (L.) Spreng., SUM, Mi
Murraya paniculata (L.) Jack, SUM, Mi
Zanthoxylum avicenniae (Lam.) DC., SUM, Mi
Zanthoxylum collinsae Craib, V, Lp
Zanthoxylum nitidum DC., V, Lp
Zanthoxylum scabrum Guill., V, Lp

SABIACEAE

Meliosma harmandiana Pierre, V, Mi
Moliosma thorelli Lecomte, V, MM

SAPINDACEAE

Allophylus brachystachys Radlk., V, Mi
Allophylus caudatus Radlk., V, Mi
Allophylus racemosus (L.) Radlk., V, Mi

Boniodendron parviflorum (Lecomte) Gagnep., V, Mi
Cardiospermum halicacabum L., V, Th
Dimocarpus longan (Lour.) Steud., NL, Mi
Euphoria fragifera Gagnep., V, MM
Lepisanthes rubiginosa (Roxb.) Leenh., V, Mi
 (*Erioglossum edule* Blume)
Litchi chinensis Radlk., V, MM
Mischocarpus oppositifolius (Lour.) Merr., V, MM
 (*M. sundaicus* Blume)
Nephelium chryseum Blume, SL, Mi
Pavieasia annamensis Pierre, V, Mi
Pometia pinnata J. & G. Forst., V, MM
Pometia sp., V, MM
Sapindus saponaria Lour., V, MM (*S. mukorossi* Gaertn.)
Xerospermum donaiense Gagnep., V, MM
Zollingera sp., SUM, Mi

SAPOTACEAE

Sarcosperma kachinense (King & Prain) Exell, V, Mi
Sideroxylon sp., SL, Na
Sinosideroxylon racemosum (Pierre ex Dubard) Aubr., SL, MM (*Sideroxylon racemosum* Lecomte)

SAURURACEAE

Gymnotheca chinensis Decne., V, H
Houttuynia cordata Thunb., V, Ch
Saururus chinensis Baill., V, Cr

SCROPHULARIACEAE

Bacopa floribunda (R.Br.) Wetts., V, Ch
 (*Herpestis moniera* H.B.K.)
Linnophila sessiliflora Blume, NL, H
Lindernia antipoda (L.) Alston, NL, Th
 (*Bonnaya veronicifolia* Spreng.)
Lindernia pedunculata Benth. var. *erecta* Bonati, NL, Ch
Mazus sp., NL, Th
Picria fel-terrae Lour., V, Th (*Curanga amara* Juss.)
Torenia finetiana Bonati, V, Ch
Torenia tonkinensis Bonati, V, Ch
Veronica anagalis L., V, H

SIMAROUBACEAE

Ailanthus triphylla (Dennst.) Alston, NL, MM
 (*Ailanthus malabarica* DC.)
Brucea tonkinensis (Lecomte) Gagnep., V, Mi
 (*B. mollis* Wall. var. *tonkinensis* Lecomte)
Picrasma sp., V, MM

SOLANACEAE

Datura striatocolor Humb. & Bonpl., V, Th
 (*D. fastuosa* L. var. *alba*)

Physalis angulata L. var. *villosa* Bonati, V, Th
Solanum biflorum Lour., V, Na
Solanum procumbens Lour., V, Lp (*S. hainanense* Hance)
Solanum indicum L., V, Na
Solanum nigrum L., NL, Th
Solanum torvum Swartz, NL, Na
Solanum verbascifolium L., V, Mi
Solanum xanthocarpum Schrad., V, Ch

STAPHYLEACEAE

Turpinia cochinchinensis Merr., V, Mi
Turpinia nepalensis Wall., V, Mi
Turpinia pomifera DC., V, MM
Turpinia sp1., V, Mi
Turpinia sp2., V, Mi

STERCULIACEAE

Abroma augusta L., V, Na
Byttneria apera Colebr., V, Lp
Byttneria echinata Wall., V, Lp
Ertolaena candollei Wall., V, MM
Firmantia colorata R. Br., V, MM
Firmantia platanifolia L., V, MM
Helicteres angustifolia L., NL, Na
Helicteres hirsuta Lour., NL, Na
Helicteres isora L., NL, Na
Helicteres lanceolata DC., NL, Na
Helicteres viscida Blume, NL, Na
Heritiera macrophylla Wall., SL, MM
Heritiera sp. nov, SUM, MM
Melochia corchorifolia L., NL, Ch
Pterospermum heterophyllum Hance, SUM, MM
Pterospermum lancaefolium Roxb., SL, MM
Pterospermum megalocarpum Tard., SL, MM
Pterospermum truncatolobatum Gagnep., SUM, MM
Pterospermum venustum Craib, SL, MM
Sterculia coccinea Roxb., V, MM
Sterculia hyposticta Miq., V, Na
Sterculia lanceolata Cav., V, Mi
Sterculia lissophylla Pierre, V, MM
Sterculia parviflora L., V, MM
Sterculia radicans Gagnep., V, Na
Sterculia tonkinensis Gagnep., V, Mi

STYRACACEAE

Styrax tonkinensis Pierre, SL, MM

SYMPLOCACEAE

Symplocos chinensis Desv. ex Merr., V, Na
Symplocos cochinchinensis Lour., V, MM

THEACEAE

Camellia caudata Wall., V, Mi
Camellia flata (Pitard) Sealy, V, Mi
Camellia tonkinensis (Pitard) Cohen-Stucort, V, Mi

Eurya trichocarpa Korth., V, Mi

THYMELEACEAE

Wikstroemia indica (L.) C. A. Mey., SUM, Mi

TILIACEAE

Colona poilanei Gagnep., V, MM

Corchorus acutangulus Lam., NL, Th

Grewia bilamellata Gagnep., SL, Mi

Grewia hirsuta Vahl, SL, Na

Grewia tomentosa Juss., SL, Mi

Grewia microcos L., NL, Mi

Triumphetta bartramia L., NL, Na (*T. rhomboidea* Jacq.)

Triumphetta pseudocana Sprag. & Craib, NL, Na (*T. tomentosa* Bojer.)

ULMACEAE

Celtis orientalis Thunb., SL, MM

Celtis sp., SUM, Mi

Gironniera subaequalis Planch., V, MM

Trema orientalis (L.) Blume, V, MM

URTICACEAE

Boehmeria holosericea Blume, V, Ch

Boehmeria nivea (L.) Gaudich., V, Na

Boehmeria nivea (L.) Gaudich. var. *tenacissima* (Gaudich.) Miq., V, Na

Boehmeria macrophylla Hornem., V, Mi (*B. platyphylla* Don)

Boehmeria tonkinensis Gagnep., V, Ch

Boehmeria sp., V, Na

Debreesia squamata King, V, Na

Dendrochride urentissima (Gagnep.) Chew, V, Mi (*Laportea urentissima* Gagnep.)

Elatostema balansae Gagnep., V, Ch

Elatostema euryhynchum Miq., V, Ch

Elatostema rupestre Wedd., V, Ch

Laportea sp., V, Th

Pellionia repens Lour., V, H (*Pellionia daveauana* N. E. Br.)

Pellionia sp1., V, H

Pellionia sp2., V, H

Petelotiella sp., V, H

Pilea alongensis Gagnep., V, Ch

Pilea boniana Gagnep., V, Ch

Pilea peltata Hance, V, Ch

Pilea peploides (Gaudich.) Hook., V, Ch

Pilea petelotii Gagnep., V, H

Pouzolzia hirta Hassk., V, H

Pouzolzia indica Gaudich., V, Ch

Pouzolzia pentandra Benn., V, Ch

Pouzolzia sanguinea (Blume) Merr., V, Ch (*P. viminea* Wedd.)

Procris sp., V, Ch

Villebrunea boniana Gagnep., V, Na

Villebrunea integrifolia Gaudich., V, Mi

Villebrunea frutescens Blume, V, Na

Villebrunea frutescens Blume var. *nivea* Gagnep., V, Na

VERBENACEAE

Callicarpa aborea Roxb., V, Mi

Callicarpa candicans (Burm. f.) Hochr., V, Na (*C. cana* L.)

Callicarpa dichotoma (Lour.) Reausch. var. *simatodenticulata* P. Do, V, Na

Callicarpa albida Blume, V, Mi (*C. longifolia* Lam.)

Callicarpa loureiri Hook. & Arn., V, Na

Callicarpa macrophylla Vahl, V, Na

Callicarpa nudiflora Hook. & Arn., V, Na (*C. revesii* Wall.)

Callicarpa rubella Lindl., NL, Mi

Callicarpa sp., SL, Mi

Clerodendrum calamitosum L., V, Mi

Clerodendrum colebrookianum Walp., V, Na

Clerodendrum cyrtophyllum Turcz., V, Na

Clerodendrum gaudichaudii P. Dop, V, Na

Clerodendrum kaempferi (Jacq.) Sieb. Ex Hassk., V, Na

Clerodendrum lecomtei P. Dop, V, Mi

Clerodendrum philippinum Schauer var. *simplex* Wu & Ifang., V, Na

Clerodendrum serratum (L.) Moon., V, Na

Clerodendrum tonkinensis P. Dop, V, Na

Clerodendron vampukii Craib, V, Mi

Congea tomentosa Roxb., NL, Lp

Duranta plumieri Jacq., NL, Na

Gmelina lacomtei P. Dop, V, MM

Lantana camara L., V, Na

Phyla nodiflora (L.) Greene, NL, Ch

Premna chevalieri P. Dop, V, Na

Premna corymbosa (Burm.f.) Rottl., V, Na

Premna flavescens Ham., V, Lp

Premna fulva Craib, V, Na

Premna stenobotrys Merr., V, Na

Stachytarphyta jamaicensis (L.) Vahl, V, Th

Verbena officinalis L., V, Ch

Vitex negundo L., SL, Mi

Vitex quinata Williams, SL, MM

Vitex stylosa P. Dop, SL, Mi

Vitex sumatrana Miq. var. *uroeolata* King, SL, MM

Vitex tripinnata (Lour.) Merr., SL, Mi (*V. leptobotrys* Hall.)

VIOLACEAE

Viola inconspicua Blume, V, Ch

VISCACEAE

Viscum articulatum Burm., SUM, Pp

Viscum articulatum Burm. var. *balansae* Lecomte, SUM, Pp

Viscum orientale Willd., SUM, Pp

VITACEAE

Ampelopsis brevipedunculata Koehne, V, Lp

Cayratia tenuifolia Gagnep., V, Ch

Cayratia sp1., V, Ch

Cayratia sp2., V, Ch

Cissus modeccoides Planch. var. *subintegra* Gagnep., NL, Lp

Cissus subtetragona Planch., V, Lp

Parthenocissus landuk Gagnep., V, Ch

Tetrastigma pachyphyllum (Hemsl.) Chun., V, Lp

Tetrastigma retinervium Planch., V, Lp

Tetrastigma tonkinensis Gagnep., V, Lp

Tetrastigma sp1., V, Lp

Tetrastigma sp2., V, Lp

Vitis pentagona Diels & Gills, V, Ch

LILIOPSIDA

ALISMACEAE

Sagittaria sagittifolia L., NL, Cr

AMARYLLIDACEAE

Crinum asiaticum L., NL, Cr

Crinum ensifolium Roxb., NL, Cr

ARACEAE

Acorus gramineus Soland., V, Cr

Aglaonema modestum Schott ex Engl., V, H (A. *siamense* Engl.)

Alocasia macrorrhiza Schott, V, H

Amorphophallus paeoniifolius (Dent.) Nicols. var. *campanulatus* (Roxb.) Sivad., V, Cr (A. *campanulatus* Roxb.)

Amorphophallus cirrifer Stapf., V, Cr

Amorphophallus tonkinensis Engl., V, Cr

Anadendron latifolium Hook., V, Ep

Arisaema balansae Engl., V, Th

Colocasia indica Hassk., V, Cr

Homalomena occulta (Lour.) Schott, V, H

Lasia spinosa (L.) Thw., V, Cr

Lasia sp., V, Cr

Pothos gigantipes S. Buchet, V, Ep

Pothos kerrii S. Buchet, V, Ep

Pothos repens (Lour.) Druce, V, Ep

Pothos scandens L., V, Ep

Pothos yunnanensis Engl., V, Ep

Raphidophora bonii Engl., V, Ep

Raphidophora decursiva (Roxb.) Schott, V, Ep

Raphidophora hookeri Schott, V, Ep

Typhonium divaricatum (L.) Decne., V, Cr

Typhonium trilobatum Schott, V, Cr

ARECACEAE (PALMAE)

Areca catechu L., NL, MM

Arenga pinnata (Wurmb) Merr., SL, Mi

Calamus platycanthus Warb., NL, Lp

Calamus pseudoscutellaris Conrard, NL, Lp

Calamus rudentum Lour., NL, Lp

Calamus tetradactylus Hance, NL, Lp

Caryota bacsonensis Mag., SL, MM

Caryota mitis Lour., V, Na

Caryota monostachya Becc., V, Ch

Caryota sympetala Gagnep., V, Mi

Licuala bracteata Gagnep., V, Ch

Licuala fatua Becc., V, Ch

Licuala tonkinensis Becc., V, Ch

Livistona saribus (Lour.) Merr. & Chev., V, MM (L. *cochinchinensis* Mart.)

Pinanga baviensis Becc., V, Ch

Rhapis micrantha Becc., SL, Ch

Rhapis laosensis Becc., SL, Na

Rhapis sp., SL, Ch

Salacca edulis Reinw., V, Mi (Zalacca *wallichiana* Mart.)

Wallichia gracilis Becc., V, Na

ASPHODELACEAE

Chlorophytum laxum R. Br., V, Cr

Chlorophytum orchidastrum Lindl., V, Th

ASTELIACEAE

Cordyline fruticosa (L.) A.Chev., V, Na (C. *terminalis* Kunth var. *ferrea* Bak.)

BURMANIACEAE

Burmanna coelestis G. Don, V, Cr

CANNACEAE

Canna edulis L., SL, Cr

Canna hybrida Hort., NL, Cr

Canna indica L., NL, Cr

COMMELINACEAE

Ancilema nudiflorum (L.) Wall., V, H

Aneilema medicum (Lour.) Kost., V, H (A. *loureirii* Hance)

Commelina benghalensis L., V, H

Commelina diffusa Burm. f., V, H (C. *nudiflora* L.)

Commelina paludosa Blume, V, H (C. *obliqua* Hance)

Floscopa glabratus (Kunth) Hassk., V, H

Floscopa scandens Lour., V, Th

Floscopa sp., V, H

Forrestia glabratus (Hassk.) Hassk., V, H

Pollia thyrsiflora (Blume) Endl., V, Cr

Rhago spathacea (Sm.) Stearn., SL, Cr (S. *discolor* Hance)

Streptolirion sp., V, H

Zebrina pendula Schinzl., V, H

CONVALLARIACEAE

Aspidistra tonkinensis (Gagnep.) Wang & Lang, V, Cr (Collania *tonkinensis* Gagnep.)

Aspidistra typica Baill., V, Cr

Aspidistra sp1., V, Cr
Aspidistra sp2., V, Cr
Disporopsis longifolia Craib, V, Cr
Disporum angustifolium Roxb., V, Cr
Disporum calcaratum D. Don var. *rubrifolium* Gagnep., V, Cr
Disporum cantonense (Lour.) Merr., V, Ch
Liriope spicata Lour., V, Cr
Neolourya pierrei Rodr., V, Cr
Neolourya wabari Rodr., V, Cr
Ophiopogon dracaenoides Hook.f., V, Ch
Ophiopogon japonicus (L.f.) Ker-Gawl., V, Cr
Ophiopogon latifolius Rodr., V, Ch
Ophiopogon longifolius Decne., V, Cr
Ophiopogon reptans Hook.f., V, Cr
Peliosanthes labroyana Pierre ex Rodr., V, H
Peliosanthes macrophylla Wall.ex Bak., V, Cr
Peliosanthes serrulata Rodr., V, Cr
Peliosanthes teta Andr., V, Cr
Polygonatum tonkinensis Gagnep., V, Cr
Tupistra tonkinensis Baill., SL, H

COSTACEAE

Costus speciosus (Koenig) Sm., V, Cr
Costus tonkinensis Gagnep., V, Cr

CYPERACEAE

Carex brunnea Thunb., SL, Th
Carex cryptostachys Brongn., SUM, H
Carex indica L., SUM, H
Carex leucociflora Bunge, SL, Cr
Carex maubertiana Boot., SUM, H
Carex trongii Khoi, SL, H
Carex sp1., V, H
Carex sp2., SU, H
Carex sp3., SM, H
Carex sp4., V, H
Cyperus compressus L., V, H
Cyperus cuspidatus K. B. K., V, Th
Cyperus difformis L., V, Th
Cyperus diffusus Vahl var. *diffusus*, V, H var. *latifolius* L. K. Dai
Cyperus digitatus Roxb., V, Th
Cyperus distans L.f., V, Th
Cyperus haspan L., V, H
Cyperus imbricatus Retz., V, Th (*C. radiatus* Vahl)
Cyperus iria L., V, Th
Cyperus nutans Vahl var. *eleusinoides* (Kunth) Haines, V, Th
Cyperus pilosus (L.) Vahl, V, H
Cyperus rotundus L., V, Cr
Cyperus tenuispica Steud., V, Th
Cyperus zollingeri Steud., V, H
Eleocharis atropurpurea (Retz.) Presl, V, Th
(*Heleocharis atropurpurea* (Retz.) Presl)
Eleocharia geniculata (L.) Roem & Schult., V,

Th (*H. caribaca* (Rottb.) Blatke, *H. capitata* R.Br.)
Fimbristylis complanata (Retz.) Link, V, Th
Fimbristylis dichotoma (L.) Vahl, V, Th
Fimbristylis diphylla Vahl var. *diphylla*, V, Th var. *pluristriata* Clarke
Fimbristylis miliacea (L.) Vahl, V, Th
Fimbristylis monostachya (L.) Hassk., NL, Th
Fimbristylis pauciflora R.Br., NL, Th
Fimbristylis quinquangularis (Vahl) Kunth, NL, Th
Fimbristylis squarrosa Vahl, NL, Th
Fimbristylis thomsonii Bockl., NL, Th
Fimbristylis umbellata Rottb., NL, Cr
Fuirena ciliatis (L.) Roxb., NL, Th (*F. glomerata* Lam.)
Heleocharis congesta D. Don, V, Th
Hypolytrum nemorum (Vahl) Spreng., V, Cr (*H. latifolium* L. C. Rich.)
Kyllinga brevifolia Rottb., NL, H
K. monocephala Rottb., NL, H
Mapania macrocephala K. Schum. & Warb., V, Cr
Mariscus compastus (Retz.) Druce, V, Th (*Sphacromariscus microcephalus* E.G.Camus)
Mariscus umbellatus Vahl, V, Cr
Pycnus flavidus Retz., var. *flavidus*, NL, Cr (*P. globosus* (All.) Reichb.) var. *strictus* Clarke
Pycnus nilagiricus Steud., NL, Cr
Rhynchospora rubra (Lour.) Makino, NL, Th (*Rhynchospora wallichiana* Kunth)
Scleria juncoides Roxb., NL, Cr
Scleria mucronatus L., NL, Cr
Scleria radula Hance, NL, Cr
Scleria supinus L., NL, Cr
Scleria tessellata Willd., NL, Cr

DIOSCOREACEAE

Dioscorea alata L., NL, Cr
Dioscorea glabra Roxb., SL, Cr
Dioscorea hamiltonii Hook., V, Cr
Dioscorea nummularia Lam., V, Cr (*D. pyrifolia* Kunth)
Dioscorea pentaphylla L., V, Cr
Dioscorea persimilis Prain & Burk., SL, Cr

DRACAENACEAE

Dracaena angustifolia Roxb., V, Mi
Dracaena cambodiana Pierre & Gagnep., SUM, Mi

ERIOCAULACEAE

Eriocaulon intermedium Koern., NL, Cr

HYPOXIDACEAE

Curculigo annamitica Gagnep., V, Cr
Curculigo gracilis Wall., V, Cr
Hypoxis sp., V, Cr

IRIDACEAE

Belamcanda chinensis (L.) DC., NL, Cr

JUNCACEAE

Juncus prismatocarpus R. Br., NL, Th

MARANTACEAE

Phrynium capitatum Willd., V, Cr

Phrynium dispernum Gagnep., V, Cr

Phrynium thorelii Gagnep., V, Cr

Stachyphrynium sp., V, Cr

MUSACEAE

Musa itinerans Chessman, V, H

Musa uranoscopus Lour. (*M. coccinea* Andr.), V, H

ORCHIDACEAE

Acampe rigida (Smith) P.P. Hunt, SL, Ep

Aerides odoratum Lour., SL, Ep

Anaphora liparioides Gagnep., V, H

Appendicula cornuta Blume, V, Ep

Arundina chinensis Blume, NL, H

Arundina graminifolia D. Don, NL, H

Bulbophyllum concinum Hook. f., SL, Ep

Bulbophyllum delitescens Hance, SL, H

Bulbophyllum lepidum (Blume) Smith, SUM, Ep

(*Cirrhopetalum siamese* Rolfe ex Donie)

Bulbophyllum nigrescens Rolfe, V, H

Bulbophyllum stenobullon Par. & Reichb.f., V, H

Bulbophyllum taeniophyllum Par. & Reichb.f.,
SL, H

Bulbophyllum xylophyllum Par. & Reichb.f., SL,
H

Calanthe angusta Lindl., V, H

Calanthe alismifolia Lindl., V, Cr

Calanthe herbacea Lindl., V, Cr

Calanthe triplicata (Willem.) Ames, V, Cr (*C.
veratrifolia* R.Br.)

Cleisostema aspersum (Reichb.f.) Garay, V, Ep

Cleisostema striatum (Reichb.f.) Garay, V, Ep

Coelogyne fimbriata Lindl., V, Ep

Coelogyne nitida Hook., V, Ep

Coelegyne brachyptera Reichb.f., SL, Ep

(*C. parishii* Auct. non Hook.f.)

Corymbokis veratrifolia (Reinw.) Blume, V, Ch

Cymbidium aloifolium (L.) Sw., V, Ep

Cymbidium lancifolium Hook.f., V, Ep

Dendrobium acinaciforme Roxb., V, Ep

Dendrobium crumenatum Sw., V, Ep

Dendrobium dentatum Seidenf., SUM, Ep
(*D. tenellum* auct. non Lindl.)

Dendrobium lindleyi Steud. (*D. aggregatum*
Roxb.), V, Ep

Dendrobium gibsonii Lindl., V, Ep

Dendrobium hercoglobum Reichb.f. (*D. poilanei*
Guill.), V, Ep

Dendrobium moschatum Sw., SL, Ep

Dendrobium nobile Lindl., SL, Ep

Dendrobium oxyphyllum Gagnep., SL, Ep

Dendrobium podagraria Hook. f., V, Ep

Dendrobium superbum Reichb.f. var. *delacurii*
Gagnep. & Guill., V, Ep

Dendropogon aducum Hook.f., V, H

Dendropogon uardianum Warner, V, H

Desmotrichum poilanei Gagnep., SUM, Ep

Eria arneri Reichb.f., SL, Ep

Eria coronaria (Lindl.) Reichb.f., SL, Ep

Eria globulifera Seidenf., V, Ep

Eria petelotii Gagnep., SUM, Ep

Erithrodes blumei (Lindl.) Schlecht, V, Ep

Erithrodes chinensis (Rolfe) Schltr., SUM, Ep

Galeola javanica Benth., V, Th

Galeola nudifolia Lour. (*G. hydra* Reichb.f.),
NL, Lp

Gastrochilus obliquus (Lindl.) Kuntze, V, Ep

Goodyera fumata Thw., V, H

Goodyera hispida Lindl., V, H

Goodyera procora (Ker-Gawl.) Hook., V, H

Goodyera soliosa (Lindl.) Benth. ex Clark, SUM,
H

Haemaria sp., V, H

Hetaria rubens (Lindl.) Benth. ex Hook.f., V, Cr

Kingidium deliciosum (Reichb.f.) Sweet., V, Ep
(*K. decumbens* (Griff.) Rolfe)

Liparis cordigera Hook.f. var. *argentopunctata*
(Aver.) Aver., V, Ep

Liparis distans Clark., V, Ep

Liparis latilabris Rolfe, V, Ep

Liparis manii Reichb.f., V, Ep

Liparis nervosa (Thunb.) Lindl., V, Ep

Ludisia discolor (Ker-Gawl.) Reichb.f., V, Cr
(*Haemaria discolor* (Ker-Gawl.) Lindl.)

Luisia morsei Rolfe, V, Ep

Malaxis acuminata D. Don, V, Ep

Malleola insectifera (J.J. Sm.) J.J. Sm. &
Schlecht., V, Ep

Neogyna sp., V, Ep

Nemweddia singapureana (Baker) Rolfe, V, Cr (*N.
balansae* Baill.)

Oberonia ensiformis (J.E. Sm.) Lindl., SL, Ep

Oberonia longibracteata Lindl., V, Ep

Oberonia myosurus (Foster) Lindl., V, Ep

Oberonia pachyphylla King & Pantl., V, Ep

Paphiopedilum appletonianum Rolfe, SUM, Cr

Paphiopedilum delenatii Guill., SUM, Cr

Pelatatheria insectifera (Reichb.f.) Ridl., SL

Phajus tankervilleae (Banks ex L'Her.) Blum,
NL, Cr

Phalaenopsis gibbosa Sweet, V, Ep

Phalaenopsis lobbii (Reichb.f.) Sweet, V, Ep

Phalaenopsis parishii Reichb.f., V, Ep

Pholidota rubra Lindl., V, Cr

Pholidota yunnanensis Rolfe, V, Cr

Phreatia secunda (Blume) Lindl., V, Cr

Physurus sp., V, Cr
Pogonia flabelliformis Lindl., NL, Cr
Renanthera coccinea Lour., SL, Ep
Robiquetia suceisa (Lindl.) Seidenf., V
Sarcanthus krempfii Guill., V, Ep
Sarcanthus sp., V, Ep
Spiranthes sinensis (Pers) Ames (*S. australis* Lindl.), NL, Cr
Sunipia andersonii (King & Pantl.) P.F. Hunt., SUM, Ep (*Ione purpurata* Braid)
Thrispermum carnosum (Ridl.) Schlectht., V, Ep
Thrispermum centipeda Lour., SL, Ep
Trichotosia curculigoides Lindl., SL, Ep
Trichotosia pulvinata (Lindl.) Kraezl., V, Ep
Vanda concolor Blume, V, Ep
Vanda doritoides Guill., SL, Ep
Vanda teres Lindl., SL, Ep
Vanda viminea Guill., SL, Ep
Vanilla annamica Gagnep., SUM, Ep
Vrydagzynea albida (Blume) Blume, V, Ep
Zeuxine nervosa (Wall.ex Lindl.) Benth.ex Clark, SL, Ep
Zeuxine vietnamica Aver., SL, Ep

PANDANACEAE

Pandanus odoratissimus L.f. (*P. loureiri* Gaudich.), V, Mi
Pandanus tonkinensis Martelli, V, Na

PHORMIACEAE

Dianella ensifolia DC., NL, H

POACEAE (GRAMINEAE)

Acroceras munroanum (Bal.) Henr., V, H (*A. crassipiculatum* (Merr.) Alston)
Apluda mutica L. (*A. varia* Hack.), NL, H
Arthraxon ciliaris P. Beauv., NL, H (*A. hispidus* (Thunb.) Makino)
Arundinella bengalensis (Spreng.) Druce, V, H
Arundinella nepalensis Trin. (*A. hispida* Hack.), NL, H
Botriochloa glabra (Roxb.) A. Camus, NL, H (*Andropogon glabra* Roxb., *Amphilophia glabra* (Roxb.) Stapf)
Capillipedium cinctum (Steud.) A. Camus, NL, H
Centotheca lappacea (L.) Desv., V, H
Chrysopogon aciculatus (Retz.) Trin., NL, H
Coix lachryma-jobi L. var. *ma-yuen* (Romanet) Stapf, V, Th
Cynodon dactylon Pers., NL, H
Cyrtococcum oxyphyllum (Steud.) Stapf, V, H (*C. pilipes* (Nees & Arn.) A. Camus)
Cyrtococcum patens (L.) A. Camus, V, H
Dactyloctenium aegyptium (L.) Willd., NL, Th (*D. aegyptiacum* Willd.)
Dendrocalamus giganteus Munro, V, PhH

Dendrocalamus longifibriatus Gamble, V, PhH
Dendrocalamus membranaceus Munro, V, PhH
Digitaria timorensis (Kunth) Bal., NL, Th (*D. propinqua* Gaudich.)
Digitaria violascens Link, NL, Th
Echinochloa colona (L.) Link, NL, Th
Echinochloa crusgalli (L.) P. Beauv., NL, Th
Echinochloa frumentacea (Roxb.) Link, NL, Th (*E. crusgalli* (L.) P. Beauv. var. *frumentaceum* Trin.)
Eleusine indica (L.) Gaertn., V, Th
Eragrostis geniculata Nees, NL, H
Eragrostis interrupta P. Beauv., NL, Th
Eragrostis nigra Nees ex Steud., NL, H
Eragrostis pilosa (L.) P. Beauv., NL, Th var. *pilosa* var. *imberbis* Franch.
Eragrostis stenophylla Hochst. ex Miq., NL, Th
Eragrostis unioloides (Retz.) Nees ex Steud., NL, Th
Eragrostis zeylanica Nees & Mey., NL, H (*E. elongata* auct. non Jacq.)
Eulalia phaeotrix (Hack.) Kuntze, var. *phaeotrix*, NL, Cr
Hackelochia granularis (L.) Kuntze, NL, Th (*Manisuris granularis* (L.) L.f.)
Hemarthria compressa (L.f.) R. Br., NL, H
Hymenachne polymorpha Bal., NL, H (*Sacciolepis polymorpha* (Bal.) A. Chase)
Imperata cylindrica (L.) P. Beauv., NL, Cr
Isachne globosa (Thunb.) Kuntze, NL, H
Isachne miliacea Roth, NL, H (*I. polygonoides* auct. non Doll.)
Ischaemum rangacharianum C.E.C. Fischer, NL, H (*I. aristatum* auct. non L.)
Ischaemum rugosum Salisb. var. *segetum* (Trin.) Hack., NL, Th
Leersia hexandra Sw., NL, Th
Leptochloa panicea (Retz.) Ohwi., V, Th (*Leptochloa filiformis* auct. non P. Beauv.)
Lophatherum gracile Brongn., NL, H
Microstegium ciliatum (Trin.) A. Camus, V, Th
Microstegium vagans (Nees) Merr., NL, Th
Miscanthus floridulus (Labill.) Warb., NL, Cr ex K. Schum. & Lauterb. (*M. japonicus* Anderss.)
Narenga porphyrocoma (Hance ex Trimen) Bor., NL, H (*Saccharum narenga* Wall.)
Neobouzeaua dulloo A. Camus, NL, PhH
Neyraudia arundinacea (L.) Herr. var. *zollingeri* (Buse) Herr., NL, H (*Arundo madagascariensis* Kunth var. *zollingeri* A. Camus)
Oplismenus compositus (L.) P. Beauv. var. *compositus*, NL, H
Oplismenus compositus (L.) P. Beauv. var. *owtani* (Honda) Nguyen, NL, H

- Panicum bisulcatum* Thunb., NL, Ch (*P. acroanthum* Steud.)
Panicum brevifolium L., NL, H
Panicum incomitum Trin., NL, H
Panicum luzoniense C. Presl, NL, Th
Paspalum conjugatum Berg., NL, Th
Paspalum longifolium Roxb., NL, H
Paspalum orbiculare Forst., NL, Ch
Paspalum scrobiculatum L., NL, H
Paspalum alopecuroides (L.) Spreng., NL, H (*P. compressum* R. Br.)
Pennisetum purpureum K. Schum., V, Th
Phragmites communis Trin., V, H (*P. vulgaris* Trin.)
Pogonatherum crinitum (Thunb.) Kunth, NL, H
Polytoca digitata (L.f.) Druce), V, Th (*P. heteroclita* (Roxb.) Koord.)
Pseudochinolaena polystachya (H.B.K.) Stapf, NL, Th
Rottboellia exaltata L.f., V, Th
Saccharum arundinaceum Retz., V, H
Saccharum spontaneum L., NL, Ch
Sacciolepis indica (L.) A. Chase, NL, Th
Schizachyrium brevifolium (Sw.) Nees ex Buse, NL, Th
Selerachne punctata R. Br., NL, Th
Setaria glauca (L.) P. Beauv., V, Th (*S. lutescens* (Weig.) P. T. Hubb.)
Setaria palmifolia (Koen.) Stapf, H
Setaria sphacelata (Schum.) Stapf & C.E. Hubb., NL, H
ex M. B. Mess (*S. aurea* Hochst. ex A. Braun)
Setaria verticillata (L.) P. Beauv., V, Th
Sinocalamus latiflorus (Munro) Mclure, NL, PhH (*Dendrocalamus latiflorus* Munro)
Sorghum nitidum (Vahl) Pers. var. *nitidum*, NL, H (*S. serratum* (Thunb.) Stapf var. *nitidum* A. Camus)
Sorghum propinquum (Kunth) Hitchc., NL, H (*S. affine* (J. Presl) A. Camus),
Sporobolus indicus (L.) R. Br., NL, H
Stenotaphrum holferi Munro, NL, H
Themeda villosa (Poir.) Dur.ex Jacks, NL, Ch
Thysanolenia maxima (Roxb.) Kuntze, NL, H
Urochloa paspaloides J. Presl ex Presl, NL, Th
(*Brachiaria ambigua* (Trin.) A. Camus),
Urochloa reptans (L.) Stapf, NL, Th
- PONTEDERIACEAE**
Eichornia crassipes (Maret.) Solms, NL, H
Monochoria vaginalis (Burm.f.) Presl, NL, Cr
- SMILACACEAE**
Smilax baubinioides Kunth, V, Cr
Smilax bracteata Presl, V, Cr (*S. stenopetala* A. Gray)
Smilax lancaefolia Roxb., V, Cr
Smilax ovalifolia Roxb., V, Cr (*S. macrophylla* Roxb.)
Smilax perfoliata Lour., V, Cr
Smilax riparia A. DC., V, Cr
- STEMONACEAE**
Stemona saxorum Gagnep., V, Cr
Stemona tuberosa Lour., V, Cr
- TACCACEAE**
Tacca plantaginea (Hance) Drenth, V, Th
(*Schizocapsa plantaginea* Hance)
Tacca integrifolia Ker-Gawl. V, Cr (*T. laevis* Roxb.)
Tacca chantrieri Andr., V, Cr (*T. paxiana* Limpr.)
- TRILLIACEAE**
Paris chinensis Franch., V, Cr
Paris hainanensis Merr., V, Cr
- ZINGIBERACEAE**
Alpinia nutans Rosc., V, Cr
Alpinia chinensis (Retz.) Rosc., V, Cr
Alpinia tonkinensis Gagnep., V, Cr
Amomum biflorum Jack, V, Cr
Amomum ovoideum Pierre ex Gagnep., V, Cr
Amomum thyrsoideum Gagnep., V, Cr
Amomum vespertilio Gagnep., V, Cr
Curcuma elata Roxb., V, Cr
Curcuma stenochila Gagnep., V, Cr
Kaempferia rotunda L., V, Cr
Zingiber cassumunar Roxb., V, Cr
Zingiber monophyllum Gagnep., V, Cr
Zingiber rubens Roxb., V, Cr
Zingiber zerumbet (L.) J.E. Sm., V, Cr

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BOOK REVIEW

STEPHEN PACKARD and CORNELIA F. MUTEL (eds.). 1997. **The Tallgrass Restoration Handbook**. (ISBN 1-55963-319-0, hbk.; 1-55963-320-4 pbk.). Society for Ecological Restoration, Island Press, 1718 Connecticut Ave. N.W., Suite 300, Washington, D.C. 20009-1148, U.S.A. (202) 232-7933. \$50.00 (hdb.), \$25.00 (pbk.). 432 pp, 26 figures, 23 tables, 6 appendices.

The *Tallgrass Restoration Handbook* addresses the increasing need and demand by natural resource managers, environmentalists, and landowners for practical guidance in the restoration and maintenance of tallgrass prairies, savannas, and open oak woodlands. As a composite work of almost 30 authors, it combines expertise gained over many years of management experimentation and practical experience. This single handy volume covers the full gamut of topics pertinent to restoration, including: setting goals and plans; collecting seeds; various seeding methods; how to conduct burns; controlling invasive plants; how to monitor vegetation; and how to reintroduce and monitor native insects, "herps," birds, and bison. Indeed, it is so encompassing that it could easily serve in an ecology course as an auxiliary text to provide practical examples and applications of many ecological concepts.

The extensive tables list seed collecting dates, species for seed mixes for particular habitats, indicator species of existing remnants, etc. However, because there is some of a bias toward authors from the northern and central Great Plains, these lists are deficient in species endemic to the southern prairies and savannas. On the other hand, the chapter on restoration options and its dichotomous key for directing one to the appropriate options is especially helpful. The book is written with a wide audience of users in mind and is remarkably free of academic jargon.—*Roger W. Sanders, BRIT Research Associate.*

A NEW SPECIES OF *EUCROSIA* (AMARYLLIDACEAE) FROM NORTHERN PERU

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ABSTRACT

Eucrosia calendulina is described as new from northern Peru. The species is related to *E. aurantiaca*, an Ecuadorean endemic, but differs by its smaller stature, fewer flowers, non-synchronized anthesis, orange perigone, and elevational range.

RESUMEN

Eucrosia calendulina se describe como nueva del norte de Perú. Esta especie está relacionada con *E. aurantiaca*, endémica de Ecuador, de la cual se diferencia por su menor estatura, por tener menos flores, su antesis no sincronizada, el perigonio anaranjado, y su rango de distribución altitudinal.

The genus *Eucrosia* Ker Gawl. is a small but polymorphic genus of Amaryllidaceae endemic to the central Andean region (Meerow 1987), allied to *Phaedranassa* Herb., *Raubia* Traub, and more distantly to *Stenomesson* Herb. Seven species were recognized by Meerow (1987), of which only three occurred in Peru; the remaining species were all Ecuadorean. Since that time, a new collection from an upper montane locality in northern Peru has revealed the existence of a previously undescribed species, further confirmed by cultivation of living material for several years.

***Eucrosia calendulina* Meerow & Sagást., sp. nov.** (Figs. 1, 2). TYPE: PERÚ. Cajamarca, Contumazá, entrada al Bosque Cachil, 2500 m, 12 Nov 1994, *Sagástegui & Leiva* 15428 (HOLOTYPE: HAO; ISOTYPES: F, FLAS).

Species nova *E. aurantiacae* affinis sed ab ea statura humiliore, anthesi non simultanea, floribus paucioribus, colore perigionali calendulino differt; haec species et iam, in altitudinibus altioribus quam *E. aurantiaca* habitat.

Geophyte from tunicate bulbs with contractile roots; bulb solitary, ovoid, 5–6 cm long, ca. 3 cm wide, tunics dark brown. Leaves hysteranthous;



FIG. 1. *Encrosia calendulina* (Sagástegui & Leiva 15428). A. Bulb in vegetative state. B. Inflorescence. C. Longitudinal dissection of flower.

petiole 12–15 cm long, 8–9 mm thick, channeled adaxially; lamina broadly elliptic, ca. 26 cm long, ca. 13 cm wide, apex shortly acuminate, base shortly attenuate, slightly and shallowly plicate, green adaxially, glaucous abaxially with a conspicuous midrib. Inflorescence scapose, umbellate (a series of

FIG. 2. *Eucrosia calendulina*.

reduced helicoid cymes), the component cymes not synchronized at anthesis; scape 50–65 cm tall, terete, glaucous, the pith more or less solid but developing a narrow central channel in distal half, terminated by 2 greenish-white, ovate-lanceolate bracts enclosing flower buds; bracts 2.5–3 cm long, soon marcescent; pedicels 7.5–16 mm long, slender. Flowers 7–10, without fragrance, protandrous; perigone funnelform-tubular, zygomorphic and laterally compressed, of six subequal tepals in two whorls united below into a tube, with one inner and two outer tepals forming a pseudolabellum surrounding stamens and style; perigonial tube 6.5–7.5 mm long, 5.2–5.5 mm wide, abruptly dilated at the base, green; tepals lanceolate, RHS Orange-Red 30A, waxy, slightly unguiculate, concave, keeled; outer tepals ca. 30 mm long, ca. 7 mm wide, apiculate; inner tepals 26–28 mm long, ca. 9 mm wide, obtuse to emarginate at slightly callose apex; stamens six, long-exserted, declinate and much exceeding perigone in length; filaments of four different lengths from 8–9 cm, green except white at base, connate in lower 1 mm, with a globose nectar gland present at base of each; anthers oblong, green, 3.5–4 mm long, dorsifixed and versatile, dehiscing introrsely by a longitudinal furrow; pollen green; style filiform, 10–11 cm long, exceeding filaments, declinate at first, ascendent when receptive; stigma ca. 1.3 mm wide, capitate, papillate; ovary trigonous-ellipsoid, 8–8.5 mm long, 4–4.5 mm wide, trilocular, septal nectaries present; ovules ca. 20 per loc-

ule, axile, biseriate, anatropous, compressed. Fruit not seen (but presumed as for genus: a glaucous, turbinate, triloculicidal capsule, turning brown at dehiscence with the pedicel elongating in fruit and with numerous, flat, obliquely winged, blackish-brown encrusted seeds). $2n = 46$.

Our new species is closely related to *E. aurantiaca* (Baker) Pax, but differs from that species in its overall smaller stature, lower number of flowers, non-synchronized anthesis, flower color, and elevation range. *Eucrosia aurantiaca* is a much more robust plant with 10–17 yellow (rarely pink) flowers that all open at once on the scape. It is endemic to Ecuador, and is not known to occur above 1200 m elevation. Other than *E. calendulina*, the only species of *Eucrosia* occurring at over 2000 m elevation is *E. stricklandii* (Baker) Meerow var. *montana* Meerow. *Eucrosia calendulina* is so far known from this single population.

ACKNOWLEDGMENTS

Karen Williams prepared the illustration of *E. calendulina*. Florida Agricultural Experiment Station Journal Series No. R- 05882.

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NOMENCLATURAL NOTES ON NEOTROPICAL CLUSIEAE (CLUSIACEAE)

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ABSTRACT

In order to validate names for various checklists and florulas now in press, new combinations for some species previously placed in *Oedematopus*, *Havetia*, and *Pilosperma* are made. The new names *Clusia engleriana* Pipoly, *C. hylaeae* Pipoly, and *C. colombiana* Pipoly are provided for *Oedematopus congestiflorus*, *O. weberbaueri*, and *Havetia laurifolia* respectively. *Clusia polyandra*, *Clusia* sect. *Pilosperma*, and *Clusia* sect. *Havetia* are new combinations based on *Oedematopus polyandrus*, and the genera *Pilosperma*, and *Havetia* respectively.

RESUMEN

Para validar los nombres de varios catálogos y flóruas ahora en prensa, algunas especies previamente ubicadas en los géneros *Oedematopus*, *Havetia*, y *Pilosperma* se transfieren al género *Clusia*. Se proponen los nombres nuevos *Clusia engleriana* Pipoly, *C. hylaeae* Pipoly, y *C. colombiana* Pipoly para los binómenes *Oedematopus congestiflorus*, *O. weberbaueri* y *Havetia laurifolia* respectivamente. *Clusia polyandra*, *Clusia* sect. *Pilosperma*, y *Clusia* sect. *Havetia* son nuevas combinaciones, basadas en *Oedematopus polyandrus*, y los géneros *Pilosperma* y *Havetia*.

INTRODUCTION

In preparing treatments of the genus *Clusia* L. for the *Flora of the Venezuelan Guayana*, *Catalogue of the Vascular Plants of Ecuador*, and *Flora de Colombia*, it has become necessary to relegate the genera *Havetia*, *Havetiopsis*, *Oedematopus*, *Quapoya*, and *Pilosperma* in synonymy under *Clusia*, in agreement with P. Stevens' as yet unpublished treatment of the family for the *Families and Genera of Vascular Plants*. A key to all the sections of *Clusia* will be presented in the treatment of the species now placed in *Oedematopus* (Pipoly & Boom, in prep.) along with the descriptions of several new ones, and the formal transfers of the genera *Havetiopsis*, *Oedematopus*, and *Quapoya* to sections under *Clusia* are in press in the *Flora of the Venezuelan Guayana* (Berry et al., in press). Additional new names for some of the taxa in *Oedematopus*, the genus *Havetia* and the genus *Pilosperma* are necessary for areas outside those treatments.

NEW NAMES AND COMBINATIONS

Clusia engleriana Pipoly, nom. nov. *Oedematopus congestiflorus* Engl., Bot. Jahrb. Syst. 58 (4/Beibl. 130):6. 1923, non *Clusia congestiflora* Cuatrecasas, Rev. Acad. Colomb. Ci. Exact. 8 (29):52. 1950. TYPE: PERU: Sandia, 2,300–2,400 m, 28 Mar 1902 (fl), A. Weberbauer 624 (HOLOTYPE: B-destroyed; ISOTYPE: F).

Distribution. —*Clusia engleriana* is known only from the eastern slopes of the Andes in Peru, 2,300–2,400 m.

Etymology. —*Clusia engleriana* is named for Adolf Engler, one of the greatest contributors to our knowledge of the family, author of the treatment of the family for Martius' *Flora Brasiliensis*.

Clusia hylaeae Pipoly, nom. nov. *Oedematopus weberbaueri* Engl., Bot. Jahrb. Syst. 58 (4/Beibl. 130):6. 1923, non *Clusia weberbaueri* Engl., Bot. Jahrb. Syst. 58 (4/Beibl. 130):4. 1923. TYPE: PERU. LORETO: near Moyobamba, 800–900 m, 14 Aug 1904 (fl, fr), A. Weberbauer 4526 (HOLOTYPE: B-destroyed; ISOTYPE: F).

Distribution. —*Clusia hylaeae* occurs at the lowland wet and premontane forest interface in the Amazon of Peru and Ecuador to approximately 1,000 m elevation.

Etymology. —The specific epithet refers to the species' habitat, in forests at the Hylaea/Andean interface.

Clusia polyandra (Vesque) Pipoly, comb. nov. *Oedematopus polyandrus* Vesque, Monogr. Phan. 8:164. 1893. TYPE: COLOMBIA. ANTIOQUIA: between Caldas and Amaga, 2,000 m, without date, F. Lehmann 3220 (HOLOTYPE: P; ISOTYPE: F).

Distribution. —*Clusia polyandra* occurs in premontane wet forests of the colombian Choco Floristic Province, 1,600–2,200 m.

Clusia sect. **Pilosperma** (Planch. & Triana) Pipoly, comb. et stat. nov. *Pilosperma* Planch. & Triana, Ann. Sci. Nat. Bot. Ser. 4, 13:315. 1860. TYPE SPECIES (by monotypy): *Clusia caudata* (Planch. & Triana) Pipoly.

An updated circumscription of the section will be presented in the upcoming treatment of the species formerly placed in *Oedematopus* (Pipoly & Boom, in prep.).

Clusia caudata (Planch. & Triana) Pipoly, comb. nov. *Pilosperma caudatum* Planch. & Triana, Ann. Sci. Nat. Bot. Ser. 4, 14:244. 1860. TYPE: COLOMBIA. CHOCÓ: Pacific coast, 1851–1857 (fl), J. Triana s.n. (HOLOTYPE: P, n.v. ; ISOTYPE: P).

Distribution and ecology. —*Clusia caudata* is endemic to the Chocó Floristic Province, occurring from the Panamanian/Colombian border to the Colombian/Ecuadorian border, from 1,100–1,700 m. It is a common epiphytic shrub.

Clusia sect. **Havetia** (Kunth) Pipoly, comb. nov. *Havetia* Kunth in H.B.K., Nov. Gen. Sp. 5:203. 1819. TYPE SPECIES (by monotypy): *Clusia colombiana* Pipoly.

Clusia colombiana Pipoly, nom. nov. *Havetia laurifolia* Kunth in H.B.K., Nov. Gen. Sp. 5:204. 1819, non *Clusia laurifolia* Planch. & Triana, Ann. Sci. Nat. Bot. Ser. 4, 13:344. 1860. TYPE: COLOMBIA [Nueva Granada]. CAUCA: Andes de Popayán, entre La Vega de San Lorenzo y Pansitara, 2,530 m, without date (fl), A. Humboldt & A. Bonpland s.n. (P-BON, n.v.).

Clusia colombiana is a common shrub in the subpáramo formations of Colombia and adjacent northern Ecuador, from 1,600–2,200 m elevation.

DOUBTFUL OR EXCLUDED NAMES

Havetiopsis martii Spruce ex Planch. & Triana, Ann. Sci. Nat. Bot. Ser. 4, 14:246. 1860. *Havetia laurifolia* Mart. Nov. Gen. Sp. Pl. 3, t. 166, 297. 1829, non H.B.K. *Havetiopsis laurifolia* (Mart.) Engl., Fl. Bras. 12:438. 1858. TYPE: BRAZIL. AMAZONAS: Rio Negro, without date, C. Martius s.n. (HOLOTYPE: M, n.v.).

I have not had an opportunity to examine the type material, housed in the Martius Herbarium (M). From the descriptions available, it may be a synonym of what has traditionally been recognized as *Havetiopsis flexilis* Spruce ex Planch. & Triana.

ACKNOWLEDGMENTS

I thank the curators of the cited herbaria who made the specimens available to me. Barney Lipscomb, Charlotte Taylor and Jon Ricketson reviewed the manuscript.

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COMMENTARIES ON ASA GRAY'S BOTANICAL TEXTBOOKS BY GRAY AND HIS CONTEMPORARIES (1836–1887)

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ABSTRACT

Asa Gray (1810–1888) authored 11 different editions of his textbooks of botany during the second half of the nineteenth century. His books were considered by his contemporaries as models, the best ones written from the views of current botanical knowledge and for covering the entire scope of the subject as known in his day. This paper describes Gray's textbooks by using information from Gray himself as taken from (1) the books' prefaces and his correspondence with botanical friends, and from (2) commentaries from other writers in published reviews of his textbooks. Based on their titles, contents, and purposes, Gray's textbooks may be placed into three categories: those that (1) discuss the basic elements or provide the essential elements, written for beginning students in schools, published in 1836, 1857, and 1887; (2) have the word "textbook" in the title, written for students at the collegiate and secondary levels, published in six rewritten editions, 1842, 1845, 1850, 1853, 1858, and 1879; and (3) have a morphological-physiological orientation written for use in elementary schools, published in 1858 and 1872. Gray's textbooks were original contributions that organized botany into a more useful science and fulfilled the educational needs of the time. They were in demand for use in schools and the public in general, but after Gray's death, no one continued preparing revisions, and thus both their use and usefulness ceased.

RESUMEN

Asa Gray (1810–1888) fue el autor de 11 ediciones diferentes de libros de texto de botánica durante la segunda mitad del siglo diecinueve. Fueron considerados por sus contemporáneos como modelos de libros bien escritos desde los puntos de vista del conocimiento botánico de su tiempo y de cubrir el espectro completo de materias conocidas en la época. Este artículo describe los libros de Gray mediante informaciones procedentes del mismo Gray tomadas de (1) los prólogos de los libros y de su correspondencia con amigos botánicos, y (2) de comentarios de otros autores en revisiones publicadas de sus libros. Basándonos en sus títulos, contenidos e intencionalidad, los libros de Gray pueden agruparse en tres categorías: (1) los que discuten elementos básicos u ofrecen estos elementos básicos, escritos para estudiantes principiantes en las escuelas, publicados en 1836, 1857, y 1887; (2) los que llevan la palabra "textbook" (libro de texto) en el título, escritos para estudiantes de segundo nivel y universitarios, publicados en seis ediciones revisadas, 1842, 1845, 1850, 1853, 1858, y 1879; y (3) los que tienen una orientación morfológica-fisiológica escritos para ser usados en escuelas elementales, publicados en 1858 y 1872. Los libros de

Gray fueron contribuciones originales que estructuraron la botánica en una ciencia más útil y satisficieron las necesidades educativas de la época. Tuvieron demanda para ser usados en escuelas y por el público en general, pero después de la muerte de Gray, nadie continuó haciendo las revisiones, y por ello cesaron tanto su uso como utilidad.

Asa Gray (1810–1888), considered the foremost nineteenth century botanist in the United States, authored 11 different editions of his textbooks of botany, regarded as among the best at that time in the United States. Published during the second half of the nineteenth century, Gray's books were considered by his contemporaries as models, because they covered the views of current botanical knowledge and the entire scope of the subject as known in his day. He wrote them at a level of comprehension and complexity different from most textbooks, in order that they would be available and useful to all ages and knowledge-levels of individuals wanting to have information about plants. Despite their widely recognized merit, no discussion, so far as is known, has ever been prepared on Gray's botanical textbooks. When one sees the various titles and dates of publication, either from a collection of the books in the library or in lists of textbooks, the complexity and confusion of this subject become apparent. Gray's biographer, A. Hunter Dupree (1959) offers very little information about Gray's textbooks, but his book has provided the chronological backdrop for the organization of this paper's text.

Because of the merit of Gray's textbooks, they are worthy of being identified and described. The procedure in this discussion follows the chronological order in which they were written and published.¹ Information about them is taken from two primary sources: (1) Gray himself, as the writer of the prefaces and correspondence with his botanical friends, and (2) commentaries in published reviews of his textbooks. Both of these sources contribute significantly and realistically toward an understanding of the content and quality of the books. The comments quoted from the reviews are the reviewers' opinions of Gray's books. Information on the content and quoted passages from the books, customarily used in the writing of book

¹ The inspiration for writing this paper on Asa Gray's botanical textbooks came while reviewing abstracts and manuscripts of papers that Emanuel D. Rudolph (1927–1992) presented in 1971 and 1975 at two history of science meetings. This effort was part of the project of editing Rudolph's unpublished papers for their publication as a memorial volume (Stuckey and Burk, eds. In Press). A short paper of Rudolph's research on Gray's textbooks (Paper No. 3) appears in that volume. This paper is in part written from notes and quoted portions of Gray's letters published by Jane Loring Gray (1893) that Rudolph had collected, with the remainder based on research by Stuckey with generous bibliographic and word processing assistance from William R. Burk, Biology Librarian at the University of North Carolina, Chapel Hill. The first draft of this paper was written in December 1995 and revised with additions in December 1996, while at the University of North Carolina, Chapel Hill.

notices and reviews during the nineteenth century, are excluded from these commentaries. The reviews examined in this study were taken from the reference list compiled by Stuckey and Burk (1998, in press).

Based on their titles, contents, and purposes, Gray's textbooks may be placed into three categories: those that (1) discuss the basic elements or provide the essential lessons, written for beginning students in schools, published in 1836, 1857, and 1887; (2) are identified with the word "textbook" in the title, written for individuals in colleges and secondary schools, or for private students, published in six rewritten editions, 1842, 1845, 1850, 1853, 1858, 1879; (3) are the books which have a morphological-physiological orientation written for young people in elementary schools, published in 1858 and 1872. Gray's textbooks are described and discussed in chronological order of their writing and publication, rather than by the grouped topic. A list of their full citations at the time of their first publication is arranged in chronological order (Appendix I). Known reprint editions based on citations published in *The National Union Catalog*, Pre-1956 Imprints (Compilers 1972) are noted at the end of each citation of the corresponding original edition. Selected features of Gray's books not discussed in the text appear as an added summary (Table 1).

A true textbook is, according to the American Textbook Publishers Institute (1949, p. 19), a published work "especially prepared for the use of pupil and teacher in a school or class, presenting a course of study in a single subject, or closely related subjects." Textbooks, particularly those of wide use, according to Rudolph (1971, a, b), are by their nature repositories of generally accepted knowledge in any discipline at a particular period. The botanical textbook is here defined as a work that introduces students to current aspects of plant science, rather than a manual for the identification of particular plants. Textbooks are useful for the historian of science because they present in a concise way the generally held paradigms² of a period. Rudolph (1975) further noted: "They [textbooks] should provide an insight into the 'normal science' of the time. For textbooks are windows to the posture that the science takes when being presented to the initiate." The concept of "normal science" comes from Kuhn (1970), who defined it for the history of science.³ The origins of textbooks are to be

² "Paradigms," according to Kuhn (1970, p. viii) are "universally recognized scientific achievements that for a time provide model problems and solutions to a community of practitioners."

³ "Normal science," according to Kuhn (1970, p. 10) is "research firmly based upon one or more past scientific achievements, achievements that some particular scientific community acknowledges for a time as supplying the foundation for its further practice. Today such achievements are recounted, though seldom in their original form, by science text-

TABLE 1. Summary of Selected Features of Asa Gray's Botanical Textbooks

Abbreviated Title of Book	Year on Title Page	Year of Copyright	Copyright Owner	Date of Preface	Number of Illustrations ¹	Illustrator	Number of Additional Printings	Changes from Previous Edition
Group 1. <i>Elements and Lessons</i> :								
<i>Elements</i>	1836	1836	G. & C. Carvill & Co.	April 1836	125 ^a		none	_____
<i>First Lessons</i>	1857	1857	George P. Putnam & Co.	1 January 1857	367 ^b	Isaac Sprague	17	_____
<i>Elements</i>		1887	Asa Gray	March 1887	589 ^b	Isaac Sprague	3	"new and much revised"
Group 2. "True" <i>Textbooks</i> :								
<i>Textbook</i> ed. 1.	1842	1842	Wiley & Putnam	No Preface	78 ^a	Miss Agnes Mitchell;	none	_____
<i>Textbook</i> ed. 2.	1845	1842	Wiley & Putnam	March 1845	1,045 ^b	Mr. J. J. Butler additional illustrations by	none	portions "entirely rewritten"
<i>Textbook</i> ed. 3.	1850	1850	George P. Putnam	April 1850	1,207 ^b	Isaac Sprague additional illustrations by	none	"rewritten and enlarged"
<i>Textbook</i> ed. 4.	1853	1853	George P. Putnam & Co.	March 1853	1,207 ^b	Isaac Sprague same as edition 3	none	"corrections and minor alterations"
<i>Textbook</i> ed. 5.	1858	1857	Iverson & Phinney	September 1857	1,336 ^b	Isaac Sprague	15	"almost entirely rewritten"
<i>Textbook</i> ed. 6.		1879	Asa Gray	10 April 1879	695 ^b		5	"entirely rewritten"
Group 3. "Botany for Young People:"								
<i>How Plants Grow</i>		1858	Iverson & Phinney	No Preface	519 ^b	Isaac Sprague	25	_____
<i>How Plants Behave</i>		1872 1900	Asa Gray Jane L. Gray	2 February 1872	40 ^b	Isaac Sprague	4	_____

¹Figures are numbered by two methods:

^aEach figure contains one or more individual illustrations, each designated with the letters a, b, c, etc. ^bEach individual illustration is given a figure number.

found in works such as Linnaeus' *Philosophia Botanica* (1751). The Linnaean model persisted throughout the eighteenth century and stressed gross structure and history as a tool for classification. This model, which was used in books in England and on the European Continent, was gradually replaced by works having greater emphases on plant function and geography. Asa Gray's botanical textbooks were examples of these latter works.

Of Gray's textbooks, Joseph C. Arthur (1895, p. 362) of Purdue University in his vice-presidential address of 29 August 1895 to Section G, Botany, of the American Association for the Advancement of Science spoke as follows:

Botany, as a substantial part of the curriculum, cannot be said to have received recognized standing in the American educational system until the time of Asa Gray. In the latter part of the decade of the thirties his first text-book, the 'Elements of Botany,' appeared, and in the decade following the 'Text-book for Colleges' and the 'Manual,' all of which works showed a true appreciation of the best features of the science and the needs of the time. They were so well conceived, and so much in demand, that new editions rapidly succeeded one another; and to the present day they hold a high place in the estimation of botanical teachers. These works possessed a specially potent element of virility in being the expression of knowledge at first hand, the words of the master. In so far as inspiration was drawn from foreign sources it came chiefly from French and English scholars, of whom De Candolle the eldest and Robert Brown were the representatives.

WRITING THE *ELEMENTS OF BOTANY* (1836)

By early 1835, the 24-year-old Asa Gray (Fig. 1), having graduated from medical school four years earlier, had concluded he did not want to practice medicine but become an authoritative botanist. Unemployed and living at home with his father in Sauquoit, New York, he "was requested to superintend the republication of some one of the most approved European treatises" (Gray 1836, p. x). As Gray began to work, he soon concluded that the European works were much too large, illustrated with expensive engravings, or contained a considerable quantity of information which did not belong in an elementary work. Gray decided "to engage in the more formidable task of preparing an original work, expressly adapted to the use of the student of North American Botany" (Gray 1836, p. x). He resolved to write an elementary textbook in botany. Gray needed money, but of equal importance was his desire to establish himself as a reputable botanist. A

books, elementary and advanced. These textbooks expound the body of accepted theory, illustrate many or all of its successful applications, and compare these applications with exemplary observations and experiments."

"Normal science" and "paradigms" are similar in that both share in expounding the scientific achievement that is yet still open-ended to allow for various related problems to be studied or resolved by future research scientists, to whom Kuhn (1970, p. 10) refers to as the "redefined group of practitioners."



FIG. 1. Asa Gray (1810–1888), from a photograph in the Emanuel D. Rudolph collection, Archives, Herbarium, The Ohio State University, Columbus.

good textbook might initially earn \$300, but the project also might be of greater value to botanical science, for he believed that a new and original textbook should be made available. The book would be his own, like an American Lindley or a French de Candolle, arranged on the Natural System, rather than the antiquated, inferior Linnaean Sexual System as employed in the books written by Amos Eaton, and his student, Mrs. Almira Hart Lincoln Phelps. In this creative endeavor, Gray hoped to challenge

the European masters with a new standard of botanical excellence (Dupree 1959, p. 48).

Despite differences, distractions, and doubts, Gray forged ahead and wrote the manuscript during the summer and fall of 1835 and on into the winter of 1836. The book was to have a balance of information on form, function, and classification which allowed students to understand the entire science of Botany. His main concepts came from Augustin P. de Candolle of Geneva, Switzerland, the master of all fields of botany.

During the course of writing, Gray left home in the autumn of 1835 to reside in a boarding house in New York City, where he could be close to a scientific community and to publishers of textbooks. On 28 September he wrote his father: "As to my book, I am trying to make a bargain with two publishers; the prospects seem pretty fair, and I shall probably get \$300, which is the sum I insist on. I shall have a definite answer in a few days" (J.L. Gray, 1:54. 1893). Some years later while reflecting on those days, Gray noted: "[I] arranged with Carvill & Company to take my book. I think they gave one hundred and fifty dollars, which was a great sum for me" (J.L. Gray, 1:20. 1893).

To assist in proofreading and adding much to the clear, crisp, business-like prose, Gray (1880) had his 12-years older English friend John Carey, a gentleman of considerable botanical knowledge, revise the proof pages and help bring the manuscript to completion through the press. Gray signed the preface in April 1836, and 10 or 12 days later he expected the printed book. On 3 May 1836, Gray notified his friend Nathan W. Folwell, as quoted in Dupree (1959, p. 55), saying, "This preparatory training ... has prepared me most thoroughly for future progress, and if I happen to pursue Botany undividedly for a little time I shall (entre nous) be soon the best botanist in this country;" a strong boast for a young man who was soon to be age 25. Completion of Gray's first textbook came before his initial appointment to a university teaching position, his nonresident professorship appointment in 1838 at The University of Michigan (Bartlett 1941).

An original work, Gray's *Elements* was adapted to the student of North American Botany (Fig. 2). As Gray (1836, pp. x–xi) stated in the preface, its execution was not easy, chiefly because of the "difficulty of combining rigid perspicuity and philosophical accuracy with a popular form and a familiar style." To achieve this goal, Gray further wrote in the preface that he

freely made use of all the most approved works and original memoirs upon the subject that were within his reach, and has more particularly and constantly consulted the *Théorie Élémentaire, Organographie Végétale*, and *Physiologie Végétale* of De Candolle; the *Traité d'Anatomie Végétales*, and the more recent *Elémens de Physiologie Végétale et de Botanique* of Mirbel; the *Introduction to Botany*, the *Introduction to the Natural System of Botany*, and the *Ladies Botany* of Prof. Lindley; the Article *Botany*

ELEMENTS
OF
BOTANY.

By ASA GRAY, M. D.

MEMBER OF THE CESAR. LEOPOLD. CAR. ACAD. NATURE CURIOSORUM, AND
OF THE LYCEUM OF NATURAL HISTORY, NEW YORK.

Hos natura modos primum dedit : his genus omne
Sylvarum, fruticumque viret, nemorumque sacrorum.
Sunt alii, quod ipse via sibi repperit usus.

VIRG. GEORG. II. 20.

NEW-YORK :
G. & C. CARVILL & CO.
1836.

FIG. 2. Title page of Gray's *Elements of Botany* (1836).

in the seventh edition of the *Encyclopaedia Britannica*, by Mr. Arnott; and the fifth edition of the *Nouveaux Elémens de Botanique* of Achille Richard.

The *Elements*' (1836) preface outlined and described the contents, which basically contained three components: (1) Structural Botany, (2) Physiological Botany, and (3) Systematic Botany. The third component was further divided into (a) *Taxonomy*, the Principles of Classification, in which he favored the Natural System over the Artificial System of Linnaeus, (b) *Phytography*, an exposition of the Rules of Botanical Nomenclature with the idea of directing students' attention to this phase of botany whose importance had been undervalued and needlessly violated in this country, and (c) *Glossology*, the definition of the technical language used in describing plants, here confined to adjectival terms. An Appendix provided general directions for collecting and preserving plants for the herbarium, and contained a list of the plant families arranged in the Natural System.

Two reviews of Gray's *Elements* have been located. In the *American Journal of Science* (30:399. 1836), an anonymous writer, probably its editor Benjamin Silliman, wrote that Gray's book was "the best work on the philosophy of Botany that has appeared in this country, and ... that its merits will be appreciated by the numerous students of this science among us." The other review, signed "D," is believed to be Gray's friend, the physician William Darlington of West Chester, an authority on the flora of Chester County, Pennsylvania, who wrote in *The American Gardener's Magazine* (2:421–424. 1836):

... the aim of the author seems to have been to exhibit a full view of the present state of the science, with all the recent improvements and discoveries, condensed into a clear and perspicuous treatise, which, being sufficiently popular in expression, should at the same time retain that rigid accuracy so indispensably necessary to so extensive a branch of natural science. In this Dr. Gray has succeeded perfectly ... [by the] excellent arrangement of the subject, and the lucid manner in which the whole is illustrated and explained. Those persons who are not familiar with the large and expensive treatises published abroad, will find a great mass of new facts for study and digestion, and to those who are endeavoring to attain the elements of botany, we recommend this volume as a text book of the highest merit.

In later years, an anonymously written review in the *Bulletin of the Torrey Botanical Club* (6:317. 1879) referred to Gray's *Elements of Botany* (1836) as the book that provided this writer's "first insight into the science. We well recall the delight with which we read the clear elucidation of the subject—delight in the method, for we had no particular experience in the matter." Gray's British friend Joseph D. Hooker (*Nature* 37:376. 1888) noted:

The "Elements" is a noteworthy book; it was at once accepted as the best that had appeared in the States, and as second to none in the English language; its only rival was [the American edition of] Lindley's "*Introduction to the Natural System of Botany*," ... [which was used in] American schools.

PREPARING THE *BOTANICAL TEXT-BOOK* (1842)
AND ITS REVISION (1845)

In 1841, Gray began to prepare a new textbook, even though he was in the midst of a commitment with John Torrey to write a *Flora of North America* (Torrey & Gray 1838–1844). Since botany was widely taught in the schools, he could at once obtain some needed cash, and because of Amos Eaton's death in 1842, Gray would be able to reach students previously served by Eaton and his followers. Gray could also nourish a new group of botanists capable of using, but who only incidentally were purchasing, his *Flora*. During the course of writing his textbook, Gray was offered and accepted on 30 April 1842, the appointment as the Fisher Professor of Natural History in Harvard University. With an added incentive of writing a good text for his forthcoming classes, and realizing the distinguished community he was about to join, he respectfully inscribed the book to the most eminent botanist of Boston, "Jacob Bigelow, M.D., F.L.S., Professor of Materia Medica in Harvard University; author of the *Flora Bostoniensis*, and of the *American Medical Botany*." He completed writing the textbook in late July, and arrived in Cambridge in sufficient time to take on his new position in September 1842. At Harvard the demands of science and the rewards from society came into balance for Gray, and the Fisher Professorship marked a real beginning there of a continuous scientific study of botany, as botany now was most important in Gray's life. Near the end of 1842, *The Botanical Text-book for Colleges, Schools, and Private Students* was published, having two parts, comprising "An Introduction to Structural and Physiological Botany," and the "Principles of Systematic Botany." On the title page was also the identification that Gray was Fisher Professor of Natural History in Harvard University. He noted that "it was in the course of printing when I was appointed to the Fisher professorship, so that I could put that title on the title-page, and have a text-book for my class" (J.L. Gray 1:28. 1893).

As was the situation earlier when writing the *Elements of Botany* (1836), Gray met with difficulties and delays in preparing *The Botanical Text-book* (Fig. 3). He wrote (J.L. Gray 1:282. 1893) to George Engelmann in St. Louis, 30 March 1842, saying:

Owing to illness I have as yet written almost nothing, and besides have to superintend all the drawings, as they must be made by a person unacquainted with botany; and at the same time I have to correct the proofs of about thirteen sheets yet of the "Flora," so that I am almost distracted when I think how I am to accomplish it here, where I have to see personally to almost every detail. But I must do it, as I hope to lay the foundation for a popular and—what is of consequence to me—a profitable work.

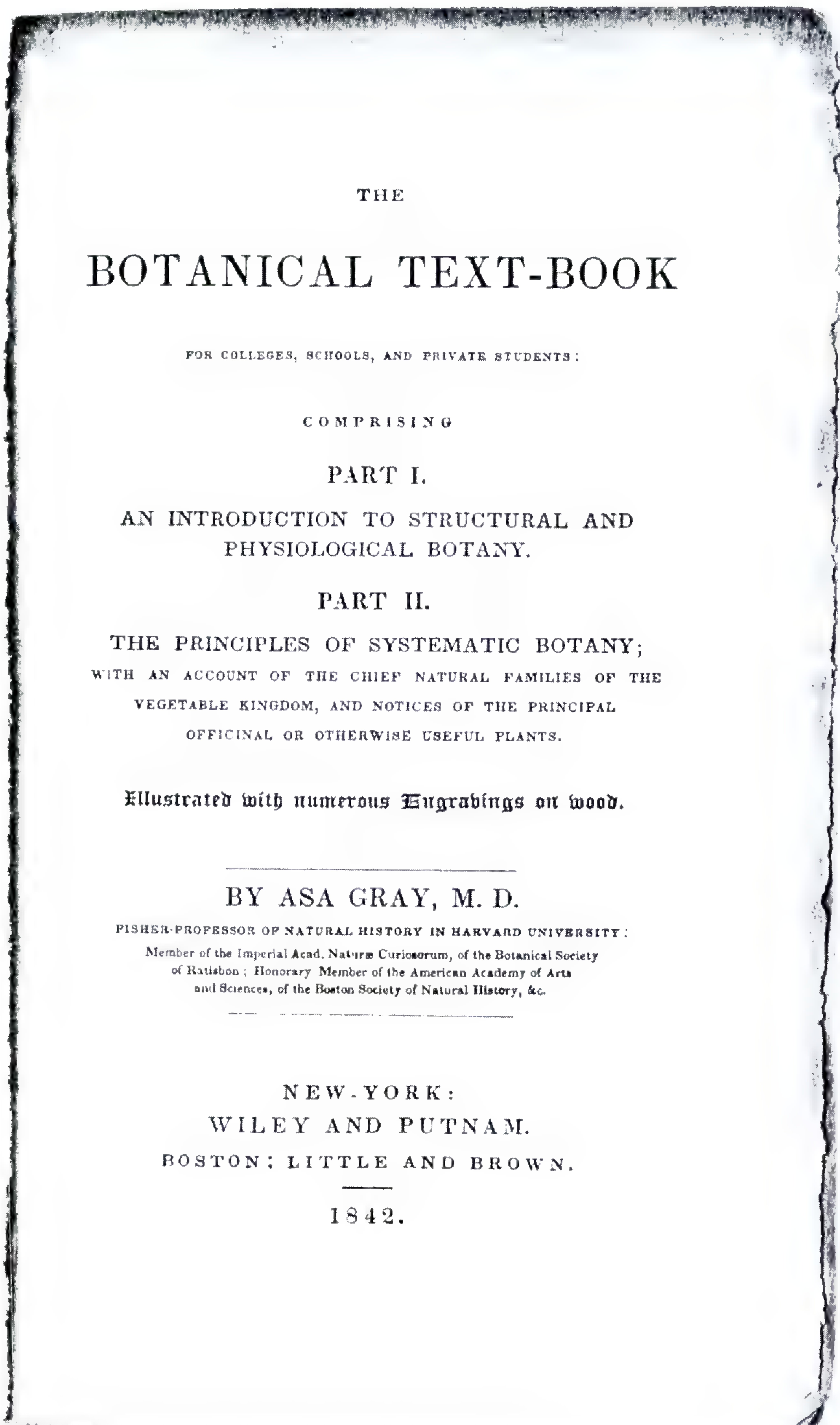


FIG. 3. Title page of Gray's *The Botanical Text-book* (1842).

No preface was written for this book, but Gray provided some comments about the first edition (1842) in the preface of the second edition (1845). Both students and botanists using the book gave favorable opinions which satisfied the author, even though the book was prepared in great haste and carried rapidly through the press. Gray agreed that the text arrangement was satisfactory, but he desired to prepare an even better book.

After the *Text-book* appeared, Gray enthusiastically wrote (J.L. Gray 1:297. 1893) to John Torrey, 3 January 1843, commenting on a review from a British journal:

The December number of [the] "Annals and Magazine of Natural History" [10:352-354. 1842] (of which Professor Balfour is the botanical editor) contains a very complimentary notice of the "Botanical Text-Book," accompanied with a few judicious selections, which shows that the writer has looked it over carefully; and winds up by terming it the best elementary treatise (as to structural botany) in the English language. So easy is it to get praise where it is not particularly deserved! ...

The major points of the review were:

It gives a comprehensive view of the present state of botanical science, and is written in a clear and lucid style, so as to render it accessible to all classes of readers. ... The work is illustrated with engravings on wood, which are highly useful to the student ... a good view is given of the principle of classification, and the Artificial and Natural methods are well explained ... The nomenclature of botany receives a due share of attention, ... Upon the whole, we look upon this work as one of the best Text-Books which ... has yet appeared.

Additionally, on the foreign scene, Gray's British friend William J. Hooker, in the *London Journal of Botany* (1:636. 1842) referred to Gray's second book as

... an immense mass of useful information, ... most perspicuously detailed, and rendered still more intelligible to the student, by the well executed figures, which are judiciously worked in with the type. We are much mistaken if this do[es] not become a popular book in our country.

A short review in *The Gardener's Magazine* (2, 3rd ser.: 634. 1842) conducted by J.C. Loudon of London stated that Gray's *Botanical-Textbook* "appears to us a very excellent work... [with] numerous woodcuts, which are very well executed; and the paper, type, and printing, are equal to those of any London publication."

The German botanist D.F.L. von Schlechtendal (*Botanische Zeitung* 1:50-51. 1843) made several comments, as noted in translation: (1) the printing and paper were superb making a positive impression, (2) the woodcuts were very clean, clear, and distinct, (3) the representative plants, taken from the North American flora, made the book especially interesting to European botanists, and (4) although concisely conceived and only intended for the beginner, Gray's text book touched upon everything interesting and worth knowing.

In the United states, two reviews are known: First, physician friend William Darlington (*American Journal of Science and Arts* 43:388–389. 1842) wrote:

The Text Book of Dr. Gray, affords at once the most compendious and satisfactory view of the vegetable kingdom which has yet been offered, in an elementary treatise, to the American public. In a style remarkable for its correctness and perspicuity, the author has traced and unfolded the vegetable structure, from its simplest forms up to its most complicated and elaborate developments. He has presented us with the first principles of the science, in accordance with the ... ["admirable doctrine of vegetable metamorphosis"] ... by which the external organs of plants are gradually modified, or metamorphosed, from the crude cotyledons of the germinating seed, to the most delicate component parts of the flower and the fruit. [Presentation of this doctrine] has, indeed, given to the science of botany an entirely new aspect.

Darlington also pointed out that with this textbook, "the teachers of botany ... may speedily elevate the study to its legitimate rank among the natural sciences... . [The student's] faculties of observation and comparison ... [will be] exercised according to the strictest rules of logic and philosophy." As Darlington further elaborated, the student can learn the true characters of the plants, to judge their economic value, and derive pleasure from studying the science itself. These advantages "may be confidently expected from the general introduction and proper use of the Botanical Text Book, ... "

Second, in the *North American Review* (56:192–207. 1843), George B. Emerson discussed and analyzed in detail various topics about plants in Gray's Textbook, including the movement of fluids in roots and stems, the theory of the transformation of leaves, the structure and symmetry doctrine of leaf arrangement, food and nutrition, and essential elements. The reviewer questioned Gray's introduction of the Natural System of plant classification in a basic textbook, when in reality the long-used Linnaean System of Classification had proven efficient and dependable for the beginning botanist in learning the organization of plants and their binomial names.

Reviewer Emerson, however, did recognize Gray's efforts to the extent that botany has become more than what Linnaeus had provided to his audience of that time period, stating that Gray's

... book puts within the reach of thousands the enlarged views and vast and exact knowledge of the Jussieus, of Linnaeus, of Richard, DeCandolle, and Robert Brown, men who deserve to be known to common fame, as among the greatest observers [of plants] and most original thinkers of the last hundred years.

Through his efforts of writing *The Botanical Text-book* (1842) Gray could serve science, and at the same time, also serve the general public. His second edition appeared in 1845, and Gray referred to this book in the preface (p. [9]) as a

... compendious treatise ... designed to furnish classes in our schools and colleges with a suitable text-book, as well as private students with a convenient introductory manual, adapted to the present condition of botanical science.

Believing that systematic botany is best studied when grounded upon structural and physiological botany, Gray wrote (1845) in the preface (p. 10) that these latter topics have been

... amplified to nearly twice ... [their] former extent, [and], ... have been almost entirely rewritten; ... the principal topics ... as far as is practicable in a brief and strictly elementary treatise ..., instead of having been rendered more abstruse by the enlargement, will rather be found to be more simple and generally intelligible than before. The chapters upon the Principles of Classification, and of the Natural System, have also been recast and somewhat enlarged.

An extensive, detailed account of this second edition appeared in the *North American Review* (61:254–258. 1845). The reviewer, George B. Emerson, stated that this new edition was necessary

... partly on the account of the rapid advancement which physiological botany ... is continually making; and partly because Dr. Gray's experience as a teacher ... has enabled him to discern ... the points which were defective, or which required more detailed explanation... . We are glad to see, therefore, that the author ... has made a good use of the opportunity, and of his professional experience, and has recomposed, and almost entirely rewritten, the first, and, in the author's view, the most essential, part of the work, that upon structural and physiological botany, ...

Among other changes were the doubling of the number of illustrative woodcuts and changes in style to render a more flowing narrative. The book was noted in the same review as being

... very neat and tasteful [in the] manner in which the mechanical part ... is finished. Its outside is as attractive as the subject of which it treats, the binding, print, paper, and engravings being not merely unexceptionable, but elegant. This is such a rare merit in a mere manual of instruction ... , a point of so much importance, that it deserves especial notice and commendation.

Later, in the July issue of the *North American Review* (67:180–182. 1848), John Carey, botanist who aided Gray with writing and proofreading his *Elements of Botany* (1836) concluded concerning Gray's 1845 edition, as well as Gray's previous elementary works, that they were

... entirely worthy of his well-established reputation. His subject is botany, but it is evident that he writes and feels as a general naturalist, and this is the point which we wish to have constantly kept in view. The details are minute and ample, and, for the most part, very concisely expressed; but he never loses sight of the great *generalizations* which must ever accompany progressive science. We think Dr. Gray has fairly realized his expressed design, "to furnish classes in our schools and colleges with a suitable text-book, ..."

D.F.L. von Schlechtendal (*Botanische Zeitung* 4:98–100. 1846), the German botanist, repeated that the examples from the North American flora serve

to recommend the work, but he was highly critical of the text on certain anatomical features, as indicated in translation:

... we find a substantial improvement in that the lesson on cells and vessels, as well as the sections that cover the main plant organs, are explained much more exactly with more consideration for all relationships and through more plentiful accompanying woodcuts. However, it seems to us that some sections are in need of elaboration, for example the one on cell contents, in which the green color should appear only in the places exposed to light and is derived from small grains. Moreover, no mention is made of either the starch nucleus of these grains or of the uniform green fluid; nor of any other colors, essential oils, or other substances that often fill entire cells. The trichome formations also are dealt with perfunctorily, and moreover no discussion is given about stellate trichomes, scales, or even of the waxy precipitates on the surface of the epidermis.

Certainly this significantly reworked edition will also find a better reception than the first, which makes this second edition necessary after only three years and at the same time serves as a witness to the ever expanding study of botany even in these regions, which, invigorated and made more common by his handbook, redounds to the author's joy and honor. Printing and paper are excellent.

THIRD EDITION OF THE *TEXTBOOK* (1850);
COMPETITOR WITH WOOD'S *CLASS-BOOK* (1845)

About 1843 or 1844, Alphonso Wood, a teacher at an academy in Meriden, New Hampshire, who professed an interest in botany, came to talk with Gray on two occasions, proposing a joint-effort in writing a botanical textbook. Wood wanted to have a textbook for secondary schools which would also serve as a manual based on the Natural System of classification for the plants of the region. Like Amos Eaton, he thought practical plant collecting and identification, rather than structural-physiological botany was the proper approach for a beginning course, and hence Gray's *Botanical Text-book* (1842) was the primary target for replacement (Lyon 1939, p. 18; Willis 1881, pp. 54–55).

Wood's production was his *Class-book of Botany* (1845), and upon its appearance was destined to do more damage to the discipline of botany than threatening the income from Gray's text-book. Wood's book, according to Lyon (1939, p. 18), was fresh, complete, and original for its emphasis upon field work. It included the fundamentals of form and function of plants and was notable for its descriptions of plants in common language that was simple and accurate. The book was appropriate for Wood's "educational scheme of its time and aroused the interest of younger people in the plants," (Lyon 1939, p. 18). In the preface of the second and sometimes later editions of his *Class-Book*, Wood (1847, p. 3) stated that his book treated the basic elements of botany according to the latest authorities, and was written in the form of simple propositions, briefly illustrated, with

short paragraphs for the convenience of the learner. For students who aim toward a much higher level of botanical understanding, Wood wrote, "it affords us pleasure to be able to recommend ... the full and elaborate 'Text Book' of Dr. Asa Gray,—an American work of the highest merit." Gray did not have a glowing opinion of Wood's *Class-book* (1845). He noticed that it gave only scant coverage to anatomical and physiological botany and featured the flora of the northeastern portion of the United States, not as a mere list of families, as in Grays' *Text-book*, but with a brief English description of each species based on several sometimes unreliable sources. In Gray's mind, Wood's classification should not be allowed to become the standard guide for American plants. Gray immediately went to work to produce his own competing botanical *Manual* (1848) and followed soon after with a rewritten and enlarged third edition of his *Botanical Text-book* (1850), only five years from the issuance of the second edition (Gray 1845). The beginning of the preface (p. [v]) in this third edition is the same as in the second edition (1845), with "the structural and physiological part ... again almost entirely rewritten ... much enlarged ... the symmetry and morphology of the flower [has] ... been altogether recast and greatly extended." In a letter of 2 April 1850 to William J. Hooker (J.L. Gray 1:368. 1893), Gray noted:

The rewriting of all the structural parts of my 3d edition of the "Botanical Text-Book," which I was inadvertently drawn into, has proved a most time consuming business. It is not yet through the press.

By the time this third edition appeared, Gray had been to Europe a second time, primarily to study specimens of North American plants deposited in European herbaria. The only review seen of this third edition is by von Schlechtendal (*Botanische Zeitung* 9:157–158. 1851), who stated in translation:

The author has used the sources that he found in Europe, as far as they were accessible to him, but he has not incorporated all of the new views into his own, rather he followed in many points older views, namely those of A. P. de Candolle. This textbook will also enjoy a wide circulation.

EDITIONS FOUR AND FIVE OF THE *TEXT-BOOK* (1853, 1858)

New editions of the textbook, the fourth (1853) and the fifth (1858), the latter under the title *Introduction to Structural and Systematic Botany*, appeared during the next decade. The preface to the fourth edition (1853, p. vi) is the same as the one in the third (1850), but with the added notation:

The changes ... are comparatively small; consisting of corrections and minor alterations, especially in the parts which relate to Vegetable Anatomy and Physiology, and in the addition of a short Chapter on the Fecundation of Cryptogamous or Flowerless Plants.

The preface to the fifth edition (1858, p. [iii]) is similar to the one in the fourth edition (1853), but contains the following additional information:

... , the structural and physiological part of the work, and the chapters on the Principles of Classification and of the Natural System, have been again almost entirely rewritten, and such changes made as the advanced state of our knowledge required, or the author's continued experience in teaching has suggested. This has been done without increasing the extent of this part of the volume, which, considering the limited time devoted to the study in our colleges, &c., is found to be as full as is desirable for a text-book.

No reviews have been located for the fourth edition; a short review notice for the fifth edition (1858) appeared in the April number of the *North American Review* (86:587. 1858). The anonymous writer noted the immeasurable superiority of the natural system on a scientific basis, but that only a very brief skeleton-outline of the Linnaean system was provided in the book. The reviewer believed a more extensive account of the Linnaean system should have been included, because of an old love for that system. The Linnaean system was helpful in the identification of plants in flower by the novice in botany. Despite this exception, "Dr. Gray's Text-Book in its present form exists ... [as a] more perfect or satisfying manual for the student or the proficient [individual] in botanical science." Another writer, Isabella James, in the October number of the *North American Review* (87:326. 1858) compared this fifth edition with Gray's first edition of 1836, pointing out that this edition (1858) is twice the size, printed on better paper, entirely rewritten, and supplied with numerous illustrations, "from the hand of Mr. Isaac Sprague, who has received the well-merited title of the most accurate of living botanical artists." This writer also stated that Gray's Botanical Text-book gained consideration abroad and "that for some years it was used as the class-book in the University of Edinburgh—a compliment seldom paid to American works, ..."

Gray's textbook was essentially written for college students and presented the rapidly developing and changing ideas in botanical science. Consequently, a great void existed for younger students who needed a simpler work, and by the 1850s most secondary and elementary schools in the country were incorporating botanical study into their curriculum. By 1855 Alphonso Wood was industriously reaping profits with his *Class-Book*, now in its 41st printing (Lyon 1939, p. 82). What was Gray to do about this gap at the elementary level of the textbook series?

WRITING BOOKS FOR YOUNGER MINDS (1857, 1858)

Gray's publisher, G.P. Putnam and Company, had financial difficulties in 1854, and Gray shifted his books to Ivison and Phinney, New York, who were active textbook publishers. Under pressure from them, Gray wrote

his *First Lessons in Botany and Vegetable Physiology* (1857), designed for high school students (Fig. 4). It was reprinted over several years, with the title changed to *Gray's Lessons in Botany*, and later combined with his book *Field, Forest, and Garden Botany* (1868) to make a single volume called *Gray's School and Field Book of Botany* (1868) (Appendix II).

Gray believed that the basics of Botany was "one of the most generally interesting of the Natural Sciences, [and] surely ought to be taught, and to be taught correctly, as far as the instruction proceeds." These words came from his *First Lessons* (1857, preface (p. [iii])). The book was

... intended for the use of beginners, and for classes in the common and higher schools, ... [The] Lessons are made as plain and simple as they well can be, ... have been carried far enough to make the book a genuine Grammar of Botany and Vegetable Physiology, and a sufficient introduction to those works in which the plants of a country—especially of our own—are described... . This work is complete in itself, as a school-book for younger classes, and even for the students of our higher seminaries... . [The book] comprises a pretty full account of the structure, organs, growth, and reproduction of plants, and of their important uses in the scheme of creation... . The book is also intended to serve as an introduction to the author's *Manual of the Botany of the Northern United States* ... and to be to it what a grammar and dictionary are to a classical author... . a full *Glossary, or Dictionary of Terms used in describing Plants*, is added to the volume.

Pennsylvania botanist Thomas C. Porter (*American Journal of Science and Arts* 73:439–440. 1857) wrote a most favorable review of Gray's *First Lessons* (1857):

Good elementary books in any branch of science are rare, ... Indeed, a good textbook of science, like a picture or a poem, is a work of art, the creation of which requires extensive knowledge, abundant resources and a generous and enthusiastic love of nature. And, even where these exist, none but a master can rightly seize the leading facts and principles and exhibit them in language at once precise, clear and simple—can be brief without being obscure and thorough without being prolix—can so fashion his teachings as to charm the youthful mind and lead it on imperceptibly into the very heart of the science—can furnish fresh and original illustrations of familiar objects in drawings and engravings, and give them that perfect accuracy which only an eye trained to a close scrutiny of forms can fully appreciate. Hence really excellent elementary books are rare indeed.

There is a special satisfaction, therefore, when these requisites are fulfilled, as is true in the case of the "First Lessons in Botany and Vegetable Physiology" from the pen of Dr. Gray. It is a model of its kind; and meeting a want long and widely felt, it must sooner or later win its way into all our schools and seminaries of learning... . Considering the intrinsic value of these books, the great care, labor and talent which have been devoted to their preparation, the good style in which they are published, and the great number and excellence of the their illustrations (from drawings by Mr. Sprague), the wonder is, that they can be sold at so moderate rates. We trust that they may meet with a circulation, proportioned to their real merit.

In England, an anonymous reviewer writing in the *Journal of Botany and Kew Garden Miscellany* (9:154–160. 1857) stated:

THE OHIO STATE UNIVERSITY
HERBARIUM LIBRARY
GIFT OF EMANUEL D. RUDOLPH

F I R S T

LESSONS IN BOTANY

AND

VEGETABLE PHYSIOLOGY,

ILLUSTRATED BY OVER 300 WOOD ENGRAVINGS, FROM ORIGINAL
DRAWINGS, BY ISAAC SPRAGUE.

TO WHICH IS ADDED A COPIOUS

GLOSSARY,

OR

DICTIONARY OF BOTANICAL TERMS.

BY ASA GRAY,

FISHER PROFESSOR OF NATURAL HISTORY IN HARVARD UNIVERSITY.

NEW YORK:
IVISON & PHINNEY AND G. P. PUTNAM & CO.,
321 BROADWAY
CHICAGO: S. C. GRIGGS & CO., 111 LAKE STREET.
1857.

FIG. 4. Title page of Gray's *First Lessons in Botany* (1857).

Professor Gray has a thorough knowledge of his subject; he is a successful teacher, a lucid and accurate writer, and a most careful compiler and analyst ... The general character of his work ... [is] both scientific and simple, and as perfectly suited to its object as any work of the kind we have seen... . It is the first good indigenous American work on Elementary Botany, and it is written to meet an urgent want ... of a book adapted for the use of the classes in the common and higher schools of the United States; ... The illustrations are good ... of the subjects ... , and are said to be, almost without exception, original, ... [with] the skill and botanical accuracy of Mr. Sprague, who stands at the head of American botanical artists. We ... highly praise Mr. Sprague's exertions in making the illustrations, wherever possible, from American plants.

The reviewer made some critical remarks about the illustrations, the order of presentation for certain selected terms referring to the organs of plants, the failure to define a few words used, and the sketchy account of the procedures for collecting plants and making an herbarium.

D.F.L. von Schlechtendal (*Botanische Zeitung* 16:151. 1858), the German botanist, made several specific comments saying that the book:

(1) Explained everything as clearly and correctly as possible, (2) Offered a true grammar of botany and plant physiology, (3) Provided a satisfactory introduction to those books in which the plants of an area are described, (4) Drew examples from the North American flora, and (5) Would serve quite well for instruction, but for readers in Germany, the dose of anatomy and physiology should be richer.

Because Gray's textbooks were considered by many educators as too advanced for a large portion of the textbook market, Gray worked many evenings preparing a simpler book, *How Plants Grow* (1858), written for "young people and common schools," as stated on the title page (Fig. 5). It too, was reprinted for many years. These two elementary books differed from the advanced textbook only in being less complex, but not in content or mode of presentation. Gray's effort was to make real science easy and simple for the younger minds. Gray realized \$500 to \$600 per year from the sale of his textbooks during this period. Most of his intellectual pursuits during the 1850s were involved with the writing of these textbooks. Gray's attitude about producing them was stated in a communication (J.L. Gray 2:438. 1893) of 26 April 1856 to his British botanical friend George Bentham:

My last book [*How Plants Grow* (1858)] in elementary botany is now just off my hands, and will be out in a fortnight. I hope it will be of use. Forgive me for writing horn-books, and I am now done with that sort of work. There were several convincing reasons for doing it.

Gray's reasons for writing textbooks for the elementary student are further elaborated in a letter of 15 May 1857 to the Rev. R.W. Church, who was the rector of Whaley, a village in Scotland (J.L. Gray 2:429–430. 1893):

An acquaintance en route for Scotland has offered to take some small parcels for me. Among them is one I have taken the liberty to address to you, a copy of a very

Botany for Young People and Common Schools.

HOW PLANTS GROW,

A SIMPLE INTRODUCTION TO STRUCTURAL BOTANY.

WITH

A POPULAR FLORA,

OR AN ARRANGEMENT AND DESCRIPTION OF COMMON PLANTS,
BOTH WILD AND CULTIVATED

ILLUSTRATED BY 500 WOOD ENGRAVINGS.

By ASA GRAY, M.D.,

FISHER PROFESSOR OF NATURAL HISTORY IN HARVARD UNIVERSITY.



NEW YORK:
IVISON, BLAKEMAN, TAYLOR, & CO.,

FIG. 5. Title page of Gray's *How Plants Grow* (1858).

elementary book [*First Lessons* (1857)] I have prepared as an introduction to my favorite science, finding there was no one in use here which I thought fit to put into the hands of young beginners. Here botany is taught, somehow or other, in most schools, and generally by incompetent teachers from wretched books, i.e., those used in the ordinary schools and for young people.

I have endeavored, in the little book I send you, to make real science as easy

and simple as possible. I doubt if I have yet aimed low enough; but the book seems to take, and promises to be useful.

As stated in Gray's introductory comments (p. 2) to *How Plants Grow* (1858), "this book is intended to teach Young People how to begin to read" about the vegetable kingdom. Conceived as the first of a two-part work on "Botany for Young People and Common Schools," this book has two major parts. The "First Part" considers how plants grow, and what their parts or organs are; how plants are propagated or multiplied in numbers; why plants grow; and how plants are classified, named, and studied. The "Second Part" consists of a popular flora for beginners for classifying and describing common wild and cultivated plants of the country. Following these parts is a dictionary of botanical terms used in this book.

Slightly over a year later on 1 June 1858, after *How Plants Grow* (1858) had been published, Gray sent the Rev. Church a copy of that book, with the following letter (J.L. Gray 2:444–445. 1893):

Last week the publishers at my request, sent ... a copy of a new and more elementary book [*How Plants Grow* (1858)] of mine than the one you are pleased to compliment. I intended that as a kind of horn-book, which Dr. Hooker insists it is not; and as something more simple was wanted here, to lead the way both to the "Lessons" and especially to the "Manual," which is rather strong for beginners, I have tried again, and you will see the result. I should have made the little "Popular Flora" fuller if the publishers had allowed more room. Having last year reëdited my "Botanical Textbook" ..., I have now done my part in elementary botanical writing, and I return with zest to my drier investigations ...

An anonymous reviewer (1858) in the *American Journal of Science* (76, 2nd ser., 26:139–140. 1858) wrote concerning *How Plants Grow* (1858):

The work is simple in style, and beautiful in its illustrations. While teaching with clearness the details of the subject, it is constantly bearing the mind, by simple explanations, above these details to higher thoughts and principles, and preparing it for the fuller survey of the science in the more extended works of the author's series... . The excellence of the volume consists in its being really "science made easy"—not by culling out "interesting facts" to attract, and tying them artfully together, but by presenting the *system of fundamental truths* in a manner intelligible and attractive to the young mind.

In the October number of *North American Review* (87:322–326. 1858), Isabella James stated with reference to Gray's two books for young people, *The First Lessons* (1857) and the *How Plants Grow* (1858):

The excellence of these elementary books is what every one who has had any knowledge of Dr. Gray's previous works must have expected; for to a perfect knowledge of his subject he adds a clearness and exactness of style seldom met with, and the power of condensing in a few words a great amount of information. As an accurate analyst, he has received a just meed of praise from all foreign botanists. Standing as he does at the head of the science in our own country, and scarcely inferior to

any botanist of the Old World, we consider it a subject of congratulations that he has found time, among his multifarious avocations of a high order, to write two books expressly for the young. The urgent need of a botanical primer, to introduce so charming a study into the school-room in a form attractive to children, has long been felt. The habits of observation, research, memory, and judgment ... are the very qualities which are most needed in every day's practical life; and if by proper educational training these discriminating powers are quickened at an early age, they will continue a constant and unfailing source of instruction and delight.

[*How Plants Grow* (1858)] ... may be truly called a wonderful book. The style is thoroughly scientific, and yet so clear and simple that even a little child can understand it, and become interested in the subject. It is not, like some popular works, written so far down to the comprehension of the young as to become a weak mixture, where science is diluted to the lowest possible standard, as if to keep the young mind for ever in swaddling-bands; but it is arranged and designed so to educate and expand the intellect as that a young person of ordinary capacity is soon able to seize upon, and comprehend, the principal features of the vegetable world.

When a work like this, combining in so rare a manner the two sterling qualities of excellence and cheapness, adapted expressly to young persons, and arranged for the use of schools, emanates from the highest botanical authority, we trust a discriminating public will show a just appreciation of its merits, by discarding all the trashy volumes now in use, and adopting one which comprises in a small space the learning and research of a life devoted to the subject.

Botanical historian Frederick Brendel (1879, p. 754) wrote, "For until Prof. A. Gray's popular book, 'How Plants Grow' appeared in 1858, not a single work of any importance [for young people] was published in this country." In France, in the *Bulletin de la Société Botanique* (15:655–656, 1858), an anonymous writer noted that "L'exécution typographique en est fort remarquable," for the 500 figures drawn by Isaac Sprague, the most accurate botanical illustrator of that time (Rudolph 1990).

FOUR-PARTS PROJECTED FOR THE *TEXT-BOOK'S* SIXTH EDITION (1879, 1885)

Twenty years passed before Gray returned in the late 1870s to the task of revising the fifth edition of his *Text-book* (1858). In 1872, Gray contemplated doing the revision, but time proving insufficient, he asked George L. Goodale, his new colleague, to help in its preparation. Goodale came to Harvard University in the fall of 1872 to assume some of the regular classes taught by Gray. During the following year Gray retired from classroom teaching, and Goodale received the appointment as Fisher Professor of Natural History. Much new information had become available in the now-expanding and more widely developing botanical discipline since the fifth edition was published, and Gray conceived that the new version would need to be expanded into several parts.

A four-volume effort was envisioned, and the first volume on *Structural*

Botany (1879), concerning the morphology, taxonomy, and phytography of phanerogams was, compared to previous editions, entirely rewritten by Gray. According to the preface (p. [iii]):

The present treatise is intended to serve as a text-book for the higher and completer instruction. To secure the ... whole range of subjects, it has been decided to divide the work into distinct volumes, each a treatise by itself, which may be independently used, while the whole will compose a comprehensive botanical course. This volume, on the Structural and Morphological Botany on Phaenogamous Plants, properly comes first. It should thoroughly equip a botanist for the scientific prosecution of Systematic Botany, and furnish needful preparation to those who proceed to the study of Vegetable Physiology and Anatomy, and to the wide and varied department of Cryptogamic Botany.

After the book was available, Gray mailed one to George Engelmann, 22 May 1879 (J.L. Gray 2:687. 1893), noting: "I send you by mail a copy of my new 'Text-Book.' You see I relegate to other hands the anatomy, physiology, and cryptogamia,—glad to be rid of them." Indeed, not all of the usual botanical information was included in the first volume of the new sixth edition.

In the extensive review of the Sixth Edition, Gray's colleague George L. Goodale (*American Journal of Science and Arts* 118:73–76. 1879), reminded the reader that in Gray's first book, *The Elements of Botany* (1836):

The plan of this early work was generous in its scope, and was philosophically developed. A morphological basis was adopted as the only safe one on which to build, and upon this a symmetrical superstructure was erected. It was no ordinary sagacity which led a young botanist, without experience in teaching, to select a method which has needed no essential change for forty years, and which is to-day generally accepted as best adapted to elementary and advanced instruction. The "Text-book," which was developed from the earlier "Elements of Botany," has passed through several editions ... A still further development of the plan ... necessitated a division into separate volumes, ... [of which this volume is the first of four volumes planned]... The present volume ... is adapted ... to the wants of the advanced student and the working botanist alike.

An anonymous author in the *Bulletin of the Torrey Botanical Club* (6:317–320; 328–329. 1879) wrote that Gray's Part I of the Sixth Edition (1879)

... will undoubtedly for years to come be the main text book on the science in our colleges and scientific schools, containing as it does the latest results in this department, treated with a mastery and a clearness of which we know no equal.

Henry Trimen, the editor of *The Journal of Botany British and Foreign* new ser. (8:253–254. 1879), published at the British Museum in London also reviewed Gray's sixth edition, Part I (1879). After noting that the book "is strictly devoted to the morphological anatomy of Phanerogams with sections on the principles regulating their classification, description, and nomenclature," Trimen wrote:

It was, indeed, the masterly and philosophical treatment of these sections of the science which always gave to the *Text-Book* its special value; they have been particularly the branches to which the author's long and laborious life has been devoted, and it is with great satisfaction that botanists will receive this fuller treatment of them at his hands.

The whole has been entirely re-written, and it is scarcely necessary to say, well written. Dr. Gray is able to convey strictly technical instruction in the attractive and easy style only reached by a few masters.

Charles E. Bessey, one of Gray's former students who became a distinguished teacher of botany, wrote in the *American Naturalist* (14:870. 1880), that Gray's Sixth Edition (1879) ranked "as one of the best books on structural botany extant." An anonymous reviewer in the *Bulletin de la Société Botanique de France* (26:165. 1879) commented on its successful perfection, as were each of the previous editions.

Later, George L. Goodale published the second volume on *Physiological Botany* (1885), but the two remaining planned volumes were never published. Gray's other colleague William G. Farlow was to write the third volume on an *Introduction to Cryptogamic Botany, both Structural and Systematic*, and Gray the fourth volume on a *Sketch of the Natural Orders of Phanerogamous Plants, Including Their Special Morphology, Classification, Distribution, and Products*. Farlow (1890) wrote: "It is deeply to be regretted that he [Gray] was never able to write this volume, for it would have enabled him to present the general views on classification derived from a long and exceptionally rich experience." He did not comment on why his own volume number three also was not written.

An anonymous reviewer of Goodale's *Physiological Botany* (1885) in the *Botanical Gazette* (10:392–393. 1885) wrote:

... here is a really new book; not new in its facts, of course, but essentially new in the arrangement, and thoroughly original in the presentation of them ... [A] very wide range of literature from which these facts have been gathered ... [and] copious references to the literature, and in many cases a citation of the passage in point ... The reader will also be impressed with the comprehensiveness of the treatment.

J.C. Arthur (1895, pp. 369–370) spoke of Goodale's Part II as a work covering a broad scope, including histology, anatomy, and ecology, as well as physiology proper. Of the last item, he recognized it as

... by no means the most conspicuous part of the book. The encyclopedic ful[l]ness of the work better adapted it for a reference-book to accompany a course of lectures than as a textbook. It greatly helped the science in America however, especially as it stimulated experimental study by a set of laboratory exercises given as an appendix... [Goodale's book] appeared ... first, and to the present [is] the only treatise on physiological botany by an American author.

MORE BOOKS FOR ELEMENTARY STUDENTS (1872, 1887)

Gray's earlier book *How Plants Grow* (1858), was as stated on the title page, a simple introduction to structural botany with a popular flora illustrated with 500 wood engravings. Furthermore, the title page identified the book as "Botany for Young People and Common Schools." Having years earlier written to the Rev. R. W. Church of Scotland that he had finished his writing of textbooks for children, the urge; however, must have returned. Gray now wrote a companion book to *How Plants Grow*, calling it *How Plants Behave* (1872), which as stated in his preface (pp. [vii–viii]) was a topic to which he "long wished to introduce pupils of an early age." He described that topic as being

... admirably adapted, while exciting a lively curiosity, to stimulate both observation and thought, ... Not only [should young people ask about] 'How Plants Grow,' but [also] 'How Plants Act.' [The plant phenomena] in certain important respects [are] easy to be observed,—everywhere open to observation, but (like other common things and common doings) are very seldom seen or attended to. [It adds] some very interesting chapters to the popular history of Plant-life... written with a view to elementary instruction ... with all practicable plainness, the subjects here presented are likely to be as novel, and perhaps as interesting to older as to younger readers.

[Gray hoped that] this little treatise, designed to open the way for the young student into this new, and, I trust, attractive field, may be regarded as a supplement to the now well-known book, [*How Plants Grow*].

Gray discussed three major topics in *How Plants Behave* (1872): (1) The motions of plants including climbing, (2) plants that are carnivorous, and (3) the fertilization of plants by insects. These themes are discussed in "the simplest and [yet] most comprehensive statement" made by the author, as noted by the Rev. C. E. Bolles in the *American Naturalist* (6:475–477. 1872). This reviewer stated further that Dr. Gray

... appears to recognize a personality in plants—at least he is careful, all the way through, to show that the actions which he explains are the result of the plant's will; and just as far as botanical science allows, he assigns the reasons for them.

An anonymous reviewer in the *Bulletin of the Torrey Botanical Club* (3:35. 1872), noted:

The book is attractive in form, and we hope [it] may lure the young to our favorite study. To more mature minds, imbued with a love of Nature, it cannot fail to prove of great interest.

Following Gray's death in 1888, Joseph D. Hooker (1888) in his account of Gray's life wrote that these two smaller books "for charm of matter and style, have no equal in botanical literature ..."

In 1887, just before departing on his last European journey, Gray finished

a small book, *The Elements of Botany* ... (1887) containing in an abbreviated format the substance of the earlier *Structural Botany Textbook* (1879), as well as some chapters on cryptogams. He chose the same title for this book as he had for his earliest book in 1836, but since those copies were long out-of-print and rarely seen, he saw no inconvenience by reusing the former title. The book was identified on the title page as being "for beginners and for schools." It also replaced his *Lessons in Botany and Vegetable Physiology* (1857), published 30 years previously. As stated in the *Elements*' preface (pp. [iii]–iv), the book was for beginners learning structural botany and the principles of plant life, mostly as they pertained to flowering plants, "with which botanical instruction should always begin" to quote Gray. The book was also to be a companion and interpreter for his Manuals and Floras.

... this treatise should teach that the study of botany is not the learning of names and terms, but the acquisition of knowledge and ideas... the Glossary ... has been considerably enlarged. It ... include[s] not merely the common terms of botanical description but also many which are unusual or obsolete.

George L. Goodale, in his review in the *American Journal of Science and Arts* (134:495. 1887), described Gray's *Elements* (1887), as a new work differing

... in many features from any of its predecessors. It embodies the grammar of Organography, the first principles of Vegetable Physiology, and of Botanical classification, and gives with the help of an adequate glossary, directions for the description of plants. The bringing so much within so narrow a compass has been accomplished by giving the kernel of every topic with out any husks ... It is ... adapted to the wants of classes and of those who are obliged to study by themselves.

Charles E. Bessey, recognized as a master of the botany teaching profession, wrote a review in the *American Naturalist* (22:46–47. 1888), comparing in numerous details Gray's first *Elements* (1836) and this *Elements* (1887). For example, in the first book, 18 pages were written on the Linnaean Sexual System, and 44 pages were devoted to the Natural System, which was necessary to justify its inclusion. In this book

... a short paragraph is all that remains of the discussion of the Linnaean System, and less than two pages suffice for the Natural System... Not only do these contrasts show us what advances have been made in botany in half a century, but a comparison of these two books shows, still more, the remarkable growth and perennial youth of the master-mind who wrote them. It is not given to many men to live to see such great changes in the aspect of science as has been the good fortune of Dr. Gray, and still fewer have had the strength or ability to adapt themselves to the new views and theories.

Walter Deane (1888, p. 65), Gray's friend and obituary author, noted that these "two books are a most fitting Alpha and Omega to his industrious life. [Of the latter], he always spoke with much enthusiasm in regard to this revised work and seemed much pleased with the result."

In the *Botanical Gazette* (13:41. 1888), an anonymous reviewer stated, concerning Gray's *Elements* (1887):

No text-book has been more widely used than the one of which this is a revision; and nothing could be more appropriate than for the author himself to give a final revision, which has been long demanded by our rapid advance in knowledge. There can be no doubt that this is the best book for its purpose that we now have.

This writer pointed out errors in the use of anatomical terminology and the choice of poorly illustrated "old figures," but concluded with a final statement:

Although more concession to the results of modern botanical work might have been expected, the author may have been wisely conservative, and his justly great name insures a book that can be trusted.

British botanist James Britten, writing in the *Journal of Botany British and Foreign* (26:92–93. 1888), provided a review of Gray's *Elements* (1887):

This new edition of an old favourite ... [is] the last which will come from the hand of the venerable and kindly writer... Dr. Gray's work, throughout his long and active botanical career, has been marked by clearness and consistent usefulness; and these characteristics are as noticeable in a work like the present as in the greater undertakings by which his position among botanists has been secured.

FURTHER CONTEMPORARY COMMENTS OF EVALUATION

Charles Bessey (1888, p. 280) considered Asa Gray "a great man." As a New York village school boy, Gray was "so far removed from all incentives to the study of science, [nevertheless he became] the future leader of one of the great branches of science in America."

With Gray's death on 30 January 1888, the pen of nineteenth century America's greatest botanical textbook writer was laid to rest. Joseph D. Hooker (1888) wrote after Gray's death:

... [the *Elements of Botany* (1836)] ... was the first of a series of editions of a work that has been for nearly half a century the text-book of schools and colleges throughout the United States, and the latter issues of which have been generally recommended by the botanical professors of the United Kingdom as the best of its class.

Gray's colleague in cryptogamic botany at Harvard University, William G. Farlow (1890, pp. 772–773), summed Gray's contributions to the writing of botanical textbooks as follows:

No better text-book on the subject had ever been written in the English language than Gray's "Text-Book" in the original form; and, although botanical instruction is now very different from what it used to be, it is still true that, as an introduction to the study of Phaenograms [i.e. Phanerogams], the group to which beginners naturally turn their attention, the later "Structural Botany," is likely to hold its own for some time to come.

Dr. Gray had the rare faculty of being able to adapt himself to all classes of readers. With the scientific he was learned, to the student he was instructive and suggestive, and he charmed the general reader by the graceful beauty of his style,

while to the children he was simplicity itself. The little books, "How Plants Grow," and "How Plants Behave," found their way where botany as botany could not have gained an entrance, and they set in motion a current which moved in the general direction of a higher science with a force which can hardly be estimated. His scientific friends, especially those abroad, sometimes blamed him for spending time in popular writing; but he may have understood himself and his surroundings better than they. With him botany was a pleasure as well as a business. Few wrote as easily as he, and, so long as he spent most of his time in higher work, he certainly had a right to amuse himself with writings of a popular character if he chose. As it was, he interested a multitude of readers in the subjects which he had at heart

Later, Farlow (1895, pp. 173, 174–175) further wrote:

The numerous editions of Gray's *Text-Book* made his name known in all the higher schools in the country, . . . He left a great nation in which, very largely through his exertions, the value of botany had become generally recognized and in which a crowd of young workers had arisen anxious to carry out the good work

SUMMATION

Asa Gray's recognition as the foremost nineteenth-century botanist of North America was earned not only because of his creative research and investigations on the flora of that continent, but also as an author of seven editions of his *Manual of the Botany of the Northern United States* (1848–1908). These books described the species and provided keys for their identification. Gray also may be recognized with this distinguished title because of his authorship of 11 different editions of textbooks of botany. In these books Gray developed botany into a more precise science, as he drew from the great Swedish botanist, Carolus Linnaeus, the French botanists A. P. de Candolle, A. L. de Jussieu, C. F. Mirbel, and Achille Richard, and the Englishmen Robert Brown and John Lindley. He ignored or chose not to extract from the German writers, who were well advanced in experimental laboratory approaches in the teaching and researching of botany. These approaches had not yet been inaugurated in the schools teaching botany in the United States except for the early efforts of Charles E. Bessey.

Gray's textbooks were original and fulfilled the needs of the time. They were in demand as both the purchasing population and the scientific information about the plants expanded. New editions with broader dimensions for different audiences became a necessity, and consequently previous editions were revised, rewritten, or expanded. After 1858, his books underwent many printings. As an example of the usefulness and demand for Gray's textbooks, Stuart G. Noble in his *A History of American Education* (1954) wrote that Gray's *How Plants Grow* (1858) was continued in use until 1900. From 1896 to 1900 it was

used in more schools than any other text. . . . the chief emphasis of the text was upon anatomical structure and classification. Numerous technical terms were used and

the logical treatment was maintained. Under this leadership instruction in botany became formal and highly technical.

After Gray's death, no one continued preparing revisions of his textbooks, and thus both their use and usefulness ceased. At the end of the nineteenth century, the German modeled botanical teaching laboratory was developed in the United States (Rudolph 1996). New textbooks were designed for these new teaching situations.

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APPENDIX 1

A CHRONOLOGICALLY ARRANGED LIST OF ASA GRAY'S TEXTBOOKS OF BOTANY

- 1836. *Elements of Botany*. G. & C. Carvill & Co., New-York. xiv, 428 pp.
- 1842. *The Botanical Text-book for Colleges, Schools, and Private Students: Comprising Part I. An Introduction to Structural and Physiological Botany. Part II. The Principles of Systematic Botany; With an Account of the Chief Natural Families of the Vegetable Kingdom, and Notices of the Principal Officinal or Otherwise Useful Plants*. Illustrated with numerous engravings on wood. Wiley and Putnam, New-York; Little and Brown, Boston. xii, [13]–413 pp.
- 1845. *The Botanical Text-book, for Colleges, Schools, and Private Students: Comprising Part I. An Introduction to Structural and Physiological Botany. Part II. The Principles of Systematic Botany; With an Account of the Chief Natural Families of the Vegetable Kingdom, and Notices of the Principal Useful Plants*. 2nd ed. Illustrated with more than a thousand engravings on wood. Wiley and Putnam, New-York. [1–9], 10–509 pp.
- 1850. *The Botanical Text-book, an Introduction to Scientific Botany, Both Structural and Systematic. For Colleges, Schools, and Private Students*. 3rd ed., rewritten and enlarged. Illustrated with twelve hundred engravings on wood. George P. Putnam, New York. xii, [13]–520 pp.
- 1853. *The Botanical Text-book, An Introduction to Scientific Botany, Both Structural and Systematic. For Colleges, Schools, and Private Students*. 4th ed. Illustrated with twelve hundred engravings on wood. George P. Putnam & Co., New York. xii, [13]–528 pp.
- 1857. *First Lessons in Botany and Vegetable Physiology*, Illustrated by over 360 woodcuts, from original drawings, by Isaac Sprague. To which is added a copious glossary, or dictionary of botanical terms. Ivison & Phinney and G. P. Putnam & Co., New York; S. C. Griggs & Co., Chicago. xii, 236 pp. [Reprinted as Gray's *Lessons in Botany* beginning in 1868; Reprints listed in *The National Union Catalog* (1972):1859, 1860, 1862, 1863, 1864, 1865, 1866, 1867, 1868, 1869, 1870, 1872, 1873, 1874, 1875; Reprint also listed in WorldCat (OCLC First Search):1858, 1886].

1858. Introduction to Structural and Systematic Botany, and Vegetable Physiology, Being a Fifth and Revised Edition of The Botanical Text-book. Illustrated with over thirteen hundred woodcuts. 5th ed. Ivison and Phinney, New York; S. C. Griggs & Co., Chicago. xii, [13]–555 pp. [Title page 1858, copyright 1857; Reprints listed in *The National Union Catalog* (1972): 1860, 1862, 1864, 1865, 1866, 1869, 1870, 1871, 1873, 1874, 1876, 1877, 1878; Reprint also listed in the Harvard University Library Online Catalog: 1875; Reprint also listed in WorldCat (OCLC First Search): 1868].
1858. How Plants Grow, A Simple Introduction to Structural Botany. With a Popular Flora, or an Arrangement and Description of Common Plants, Both Wild and Cultivated. Botany for Young People and Common Schools. Illustrated by 500 wood engravings. Ivison, Blakeman, Taylor, & Co., New York. 233 pp. [Also published in 1858 by American Book Company, New York, with 233 pp.]. [Reprints listed in *The National Union Catalog* (1972): 1859, 1860, 1861, 1862, 1863, 1864, 1865, 1866, 1867, 1868, 1869, 1870, 1871, 1872, 1873, 1874, 1875, 1876, 1877, 1878, 1879; Reprints also listed in the Harvard University Library Online Catalog: 1880, 1889; Reprints also listed in WorldCat (OCLC First Search): 1881, 1900].
1872. How Plants Behave: How They Move, Climb, Employ Insects To Work for Them, &c. Botany for Young People. Part II. Ivison, Blakeman, Taylor, and Company, New York and Chicago. viii, [9]–46 pp. [Also published in 1872 by American Book Company, New York, with 46 pp.]. [Reprints listed in *The National Union Catalog* (1972): 1873, 1874, 1875, 1900].
1879. Gray's Botanical Text-book. 6th ed. Vol[ume] I. Structural Botany, or Organography on the Basis of Morphology; to Which Is Added the Principles of Taxonomy and Phytography, and a Glossary of Botanical Terms. Ivison, Blakeman, Taylor & Company, New York and Chicago. xii, 442 pp. [Reprints listed in *The National Union Catalog* (1972): 1880, 1881, 1885, 1890, 1907].
1887. The Elements of Botany for Beginners and for Schools. Gray's Lessons in Botany. Revised ed. American Book Company, New York, Cincinnati, Chicago. viii, 9–226 pp. [Reprints listed in *The National Union Catalog* (1972): 1889, 1890, 1901].

APPENDIX II

GRAY'S SCHOOL AND FIELD BOOK OF BOTANY (1868),
TWO BOOKS IN ONE

Gray's School and Field Book of Botany (1868) consisted of two of Gray's books bound together in one, the *Lessons in Botany* (1857) and the *Field, Forest, and Garden Botany* (1868). First issued in 1868, the two together formed a popular and comprehensive botanical work that could be used by beginning and advanced classes (Fig. 6). In reality, this book was Gray's answer to Alphonso Wood's earlier challenge for a textbook that presented the terminology of botany along with a manual for field identification. Wood's *Class-book* (1845), issued over 20 years previous to 1868, and still being reprinted, was still available for class use. Now, however, it was time for a book having a fresh approach that combined botanical lessons with floristic and identification information. According to the publisher's preface: [Gray's book was]

... adapted to beginners and advanced classes, to Agriculture Colleges and Schools, as well as to all other grades in which the science is taught; ... also adapted ... as a hand-book to assist in analyzing plants and flowers in field study of botany, either by [students in] classes or individuals.

It is a *Grammar* and *Dictionary* of Botany, and supplies a great desideratum to the Botanist and Botanical Teacher, there being no similar class-book published in this country.

REFERENCE

1868. Gray's School and Field Book of Botany. Consisting of "Lessons in Botany [1857]," and "Field, Forest, and Garden Botany [1868]," bound in one volume. Ivison, Blakeman, Taylor & Co., New York and Chicago. Lessons, xii, 236 pp.; Field, 7–386 pp. [Reprints listed in *The National Union Catalog* (1972): 1869, 1870, 1871, 1872, 1873, 1874, 1875, 1876, 1877, 1878, 1879, 1880, 1881, 1887, 1890, 1895, 190?]. [Reprints from 1887 and the following years, consist of Gray's *Elements of Botany* ({1887}), rather than the

GRAY'S
SCHOOL AND FIELD BOOK
OF
BOTANY.

CONSISTING OF

"LESSONS IN BOTANY," AND "FIELD, FOREST, AND
GARDEN BOTANY,"

BOUND IN ONE VOLUME.

BY ASA GRAY,
FISHER PROFESSOR OF NATURAL HISTORY IN HARVARD UNIVERSITY.

IVISON, BLAKEMAN, TAYLOR & CO.,
NEW YORK AND CHICAGO.

FIG. 6. Title page of *Gray's School and Field Book of Botany* (1868).

previous *Lessons in Botany* (1857). The title page, however, for the entire book referring to the two combined books in printings after 1887 continued to carry the subtitles, *Lessons in Botany* and *Field, Forest, and Garden Botany*].

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EMANUEL D. RUDOLPH AS A BOOK REVIEWER FOR *CHOICE*

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ABSTRACT

Emanuel D. Rudolph (1927–1992), polar lichenologist and historian of botany, held academic positions at Wellesley College (1955–1961) and The Ohio State University (1961–1992). This paper outlines the history of *Choice*, a book review serial, and Emanuel Rudolph's role as a reviewer beginning the year that *Choice* was established (1964). Important factors influencing his decision to write book reviews were: a commitment to serve colleges, an avid interest in book collecting, and sharing a similar philosophy with science historian George Sarton, who stated that those qualified should review books "because it was their professional duty to do so" (*Choice* 26:1093. 1989). For 28 publications Rudolph wrote 195 book reviews. Of these 79 appeared in *Choice* in the disciplines of botany (58), polar science (9), history of science (6), and other biological sciences (5). His book reviews demonstrate analytical and descriptive writing skills as well as a breadth of knowledge in these subject areas. Through his book reviews Rudolph provided collection development and teaching enrichment assistance for college librarians and faculty.

ABSTRACT

Emanuel D. Rudolph (1927–1992), liquenólogo polar e historiador de botánica, ocupó cargos académicos en Wellesley College (1955–1961) y la Universidad Estatal de Ohio (1961–1992). Este artículo bosqueja la historia de *Choice*, una serie de revisiones de libros, y el papel de Emanuel Rudolph como revisor empezando en el año en que se estableció *Choice* (1964). Fueron factores importantes que influenciaron su decisión de escribir revisiones de libros: el compromiso de servir a las universidades, su gran interés en la colección de libros, y compartir una filosofía similar con el historiador de la ciencia George Sarton, quien manifestó que las personas cualificadas deberían revisar libros "porque era su deber profesional hacerlo" (*Choice* 26:1093. 1989). Rudolph escribió 195 revisiones de libros para 28 publicaciones. De ellas 79 aparecieron en *Choice* en las disciplinas de botánica (58), ciencia polar (9), historia de la ciencia (6), y otras ciencias biológicas (5). Sus revisiones de libros demuestran unas habilidades analíticas y descriptivas así como un amplio conocimiento en los temas de estas áreas. Mediante sus revisiones de libros Rudolph promovió el desarrollo de la colección y el apoyo enriquecedor a la docencia para sus compañeros bibliotecarios y la facultad.

Biographical accounts of Emanuel D. Rudolph (1927–1992), polar lichenologist and historian of botany, were written by Ronald L. Stuckey (1994, 1995). Additional knowledge of Rudolph's scholarly endeavors is revealed through his book reviewing for *Choice*, a serial devoted to the pub-

lication of reviews.

The book review as known today is a relatively new form of communication, having emerged and developed after the 16th century. Its beginnings precede the advent of printing when oral criticisms of an individual's work were made. For example, on the Athenian stage during Aristophanes' comedy, *The Frogs*, a dramatized critique was made of the works of Aeschylus and Euripides. During the late 17th century when newspapers appeared, scholarly notation about books took the form of book notices to acquaint scholars with their colleagues' publications (Stueart 1978). A book review, an article published in a newspaper or periodical, announces a new book and describes and evaluates it (Donovan 1996). The *North American Review*, established in 1815, was the first periodical in the United States to provide book reviews.

Beginning mid-1963 librarians in liberal arts colleges throughout the United States received letters explaining reasons for publishing a new review journal, *Choice*, aimed at undergraduate libraries. They were asked to assist by recommending faculty at their campuses for the purpose of writing reviews. Similar announcements appeared in educational journals.

CHOICE, A PERIODICAL PUBLISHING BOOK REVIEWS

Although in the planning stages during the late 1950s, *Choice* did not begin publication until March 1964 under an initial grant from the Council on Library Resources through the Ford Foundation (Clark 1964). First housed in Olin Library, Wesleyan University, Middletown, CT, *Choice* editorial offices subsequently moved to 42 Broad Street, and later to 100 Riverview Center, both in Middletown. Richard K. Gardner was the founding editor of *Choice*, and the "architect" of its reviewing program (Sabosik 1994).

Choice, a monthly review periodical, publishes book reviews for the Association of College and Research Libraries, a division of the American Library Association. Although most of the reviews in *Choice* are for books, electronic products, and microform materials are also covered. These reviews primarily support undergraduate library collection development. *Choice* reviews are also now available on CD-ROM and online. In 1988 a publishing plan for *Choice* was approved (Sabosik 1989) and a selection policy was published in 1993 (Anonymous 1993).

The editors of *Choice* give reviewers suggestions to assist them in looking at a book. One of the most important services of the reviewer, or subject consultant, is to place a book in the literature of its subject area and to identify its undergraduate audience: freshman, senior, or advanced student. In noting the book's contents consultants consider (Anonymous [1965]): (1) What is the standard work with which the book invites comparison?;

(2) What is the relationship of the book to it? Portion of subject covered? Approach?; (3) What is the authority of the author?; (4) On what principle does the author select and order his material?; (5) What is the author's point of view?; (6) How well does he write?; (7) What is the quality of references and illustrative features (bibliography, index, map, illustrations)?; and (8) Is the book a new edition? If so, is the revision significant to warrant a new edition?

The importance and impact of volunteer reviewers were remembered and recognized by the *Choice* administration. On at least an annual basis the *Choice* editor communicated news and extended thanks to its reviewers in a memorandum, issued through the early 1970s as "Report to Consultants," and later as a cover letter accompanied by an annual "Reviewer Update Form." Sentiments of gratitude for the contribution of reviewers were expressed on numerous occasions by *Choice* editors. Especially poignant were the comments of Editor Richard K. Gardner, who stated in a letter dated 9 April 1973 that "your loyalty is much appreciated by the staff of *Choice* and also by the library community at large. . . . Without your unselfish help *Choice* could not continue to produce its 6,500–7,000 reviews a year." Reviewers were a respected and integral component of the publishing venture. Their comments and opinions were often solicited by *Choice* editors if new policies were being considered. When new consultants were needed for reviewing, existing reviewers were asked for their recommendations of colleagues. Besides keeping the books that were reviewed, consultants also enjoyed the intrinsic benefits of reading books in their area of research, and keeping up-to-date in their area of specialty. In 1991 reviewers were offered special discounts on subscriptions to *Choice*.

EMANUEL D. RUDOLPH AS A BOOK REVIEWER

Rudolph read about *Choice* and its need for reviewers in the April 1964 issue of *Scholarly Books in America*. He wrote a letter, dated 1 May 1964, to the editors of *Choice*, informing them of his keen interest in writing reviews. He mentioned that he had a strong interest in undergraduate libraries, having had some experience with them at Wellesley College, where he taught for six years, and at The Ohio State University, where he then was working with a committee to purchase books in the history of science. Although not mentioned in his letter, Rudolph also was an avid book collector. He and his wife Ann amassed an impressive, personal library of 53,000 volumes of books in botany and natural history, including an important children's collection. Twenty-five years later Rudolph wrote about another factor which influenced his interest in writing reviews. He stated that "many years ago, I read a paper by the late George Sarton (1950), founder of the field of the history of science in this country, that urged

those qualified to review books because it was their professional duty to do so" (Clark 1989). Rudolph took Sarton's comments seriously, as he eventually wrote 195 book reviews for 28 publications. While an assistant professor of Botany at Wellesley College, Massachusetts, Emanuel Rudolph published his first book review in the January 1959 issue of *Ecology* (Rudolph 1959). Rudolph wrote his first review for *Choice* in October 1965 ((Rudolph 1965). For *Choice* he wrote 79 reviews in the disciplines of botany (58), polar science (9), history of science (6), and other biological sciences (5).

The language used by Rudolph in his reviews was pointed, but descriptive. In citing the weaknesses of a book, he would refer to its "stiff translation," "inaccurate statements," "dry" style, or "poor bibliography." In stating the strengths of a book, he would comment that it had "authoritative coverage," "superior, useful illustrations," "stimulating" text, or a "masterful summary" of the field. Sometimes Rudolph extolled a book for undergraduates, such as the monograph *Fungi: Delight of Curiosity* by Harold J. Brodie (1978). About this book, he said, "All libraries . . . should have this volume that could easily spark a future mycologist" (Rudolph 1978). Rudolph's last review for *Choice* was published posthumously (Rudolph 1992).

Besides writing reviews for *Choice*, Rudolph participated in three other projects: (1) providing bibliographical citations for the revision of *Books for College Libraries* (Association of College and Research Libraries 1975), (2) submitting entries for *Opening Day Collection*, a special supplement to *Choice* (Gardner et al. 1974), and (3) contributing his comments to the silver anniversary issue of *Choice* (Clark 1989). Concerning the latter he stated that:

A distinct advantage of writing book reviews is that the books are examined with a critical eye for the audience for whom the review is written. In the case of *Choice*, my thoughts always are, would this be a book that I would want various kinds of students to find in their libraries? This perspective takes me outside of my own limited professional interests and expands my horizon. The second advantage of *Choice* reviewing is that it forces me sometimes to read critically books in my discipline that are not exactly in my particular limited field of research. This too has broadened my horizon. In short, being a *Choice* reviewer has made me a more rounded teacher and researcher, and for that I am very grateful.

Although Emanuel Rudolph's predominant book reviewing role was with *Choice*, he also held other related responsibilities. He was the book review editor of *The Ohio Journal of Science* (1965–1974). As editor (1982–1985) of *The Plant Science Bulletin*, he oversaw the book review section.

Rudolph's book reviews demonstrate analytical and descriptive writing skills and a breadth of knowledge of books in subject areas of botany, polar science, and history of biology. Through his book reviews Rudolph pro-

vided collection development and teaching enrichment assistance for college librarians and faculty.

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ARCHIVAL RESOURCES CITED AND CONSULTED

Emanuel D. Rudolph's archives dealing with his association with *Choice* are housed in the Herbarium, Museum of Biological Diversity, The Ohio State University, 1315 Kinnear Road, Columbus, Ohio 43212-1192 and curated by Dr. Ronald L. Stuckey, Professor Emeritus and Curator Emeritus, Department of Plant Biology, The Ohio State University, Columbus, Ohio.

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FLORA VASCULAR DE LA LAGUNA DE BABICORA, CHIHUAHUA, MEXICO

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RESUMEN

La Laguna de Babícora es una cuenca endorreica. Se localiza en la porción noroeste del estado de Chihuahua enclavada en la Subprovincia Fisiográfica Sierras y Llanuras Tarahumaras en la Provincia Fisiográfica de la Sierra Madre Occidental. El clima es semifrío subhúmedo. La altitud es de 2150 m.s.n.m. en los valles y 2500–2700 m.s.n.m. en los picos, con suelos aluviales y litosoles respectivamente. Las rocas predominantes son ígneas. Se presentan 2 tipos de vegetación: Bosque de Pino-Encino y Pastizal Halófito. La flora está constituida por aproximadamente 69 familias, 247 géneros y 489 especies, incluyendo a los taxa infraespecíficos. Las familias más diversas son Asteraceae, Poaceae y Fabaceae. los géneros con mayor número de especies son *Muhlenbergia*, *Cyperus*, *Euphorbia*, *Dalea* y *Desmodium*.

ABSTRACT

La Laguna de Babícora es una cuenca endorreica. Se localiza en la porción noroeste del estado de Chihuahua enclavada en la Subprovincia Fisiográfica Sierras y Llanuras Tarahumaras en la Provincia Fisiográfica de la Sierra Madre Occidental. El clima es semifrío subhúmedo. La altitud es de 2150 m.s.n.m. en los valles y 2500–2700 m.s.n.m. en los picos, con suelos aluviales y litosoles respectivamente. Las rocas predominantes son ígneas. Se presentan 2 tipos de vegetación: Bosque de Pino-Encino y Pastizal Halófito. La flora está constituida por aproximadamente 69 familias, 247 géneros y 489 especies, además de los taxa infraespecíficos. Las familias más diversas son Asteraceae, Poaceae y Fabaceae. los géneros con mayor número de especies son *Muhlenbergia*, *Cyperus*, *Euphorbia*, *Dalea* y *Desmodium*.

INTRODUCCION

La Laguna de Babícora pertenece a las áreas denominadas humedales (INEGI 1990). Es una cuenca endorreica con escurrimientos de agua semipermanentes. Se localiza al noroeste de la ciudad de Chihuahua, en los municipios de Gómez Farías y Madera en la Provincia Fisiográfica de la Sierra Madre Occidental en la Subprovincia Fisiográfica Sierras y Llanuras Tarahumaras (INEGI 1987). A la fecha no se presentan estudios florísticos de la zona ni de áreas aledañas por lo que el presente trabajo tiene el propósito de contribuir al conocimiento de la flora de la Sierra Madre Occidental. La cuenca de la Laguna de Babícora se localiza entre las coordenadas 29°05'-29°40'N y 107°30'-108°15'W. Abarca una superficie aproximada de 1882 km cuadrados. Su elevación va desde los 2150 m en los valles hasta los 2700 m en los picos montañosos. La zona de estudio tiene forma semicircular y queda circundada por las vías de comunicación que unen los poblados El Alamillo, Pablo Amaya, El Porvenir, Gómez Farías, Peña Blanca, San José de Babícora y La Libertad (Fig. 1). La fórmula climática del área presentada por INEGI (1986) es C (E)(w1)(b)(e'), semifrío subhúmedo, con lluvias en verano de tipo torrencial, verano fresco largo, y oscilaciones de temperatura media mensual muy altas. La precipitación promedio anual es de 630 mm. La temperatura media anual es de 11.5° C. Las rocas dominantes en la zona de estudio son de tipo ígneo extrusivo del Periodo Terciario. Los suelos dominantes son litosoles y lacustres, estos últimos ricos en materia orgánica, de color negro obscuro a café pardo con profundidades de hasta 2 m (Montufar 1987, INEGI 1986). La Laguna presenta un ojo de agua permanente que mana del subsuelo. Presenta escurrimientos de agua semipermanentes de arroyos que fluyen hacia el interior de la cuenca.

VEGETACION

La vegetación de la La Laguna de Babícora queda clasificada dentro de dos tipos principales: Bosque de Pino—Encino y Pastizal Halófito (INEGI 1986).

Bosque de Pino-Encino.—Es la comunidad vegetal dominante en la zona, abarcando una extensión de 1075 kilómetros cuadrados, presentándose en todos los picos montañosos que rodean a la laguna. Entre las especies dominantes de pinos están *Pinus cembroides*, *P. engelmannii*, y *P. chihuahuana*; los encinos más frecuentes son *Quercus emoryi*, *Q. arizonica*, *Q. depressipes*, *Q. hypoleucoides* y *Q. rugosa*.

Pastizal Halofito.—Constituye la vegetación predominante en las partes bajas o llanuras, abarcando una superficie aproximada de 237 km cuadrados, alcanzando una altura promedio de 30 cm, donde las especies dominantes son *Distichlis spicata* var. *stricta*, *Muhlenbergia utilis*, *Sporobolus cryptandrus*,



FIG. 1. Localización del área de estudio, escala 1: 500,000.

Eragrostis mexicana, *Cyperus odoratus*, *C. sphaerolepis*, *Eleocharis tenuis* y *Physalis sulphurea*.

FLORA

Los registros de plantas vasculares de la Laguna de Babícora comprenden 489 especies y taxa infraespecíficos, englobadas en 247 géneros y 69 familias (Tabla 1). Las familias más diversas se presentan en la Tabla 2. Los géneros con mayor número de especies se presentan en la Tabla 3. Solo una especie es endémica en la zona de estudio (*Hydropectis estradii* B.L. Turner). Todas los registros de especies se circunscriben exclusivamente a las colectas realizadas por los autores (Mayo 1994–Agosto 1995). El arreglo seguido para el listado de plantas en los grupos taxonómicos mayores para angiospermas es el propuesto por Cronquist (1988). Se sigue una secuencia alfabética en la disposición de familias géneros y especies.

ABREVIACION EN LA LISTA FLORISTICA

Colector (EE= Eduardo Estrada) y herbario donde están depositados las colecciones son BRIT, NMC, NY, TEX (Holmgren & Holmgren 1993).

TABLA 1. Flora vascular de la Laguna de Babícora.

Division	Familias	Generos	Especies
Polypodiophyta	4	7	10
Pinophyta	2	3	7
Magnoliophyta			
Clase Magnoliopsida	54	189	353
Clase Liliopsida	9	48	119
TOTAL	69	247	489

TABLA 2. Familias con mayor número de géneros.

Familia	Generos	Especies
Asteraceae	48	80
Poaceae	28	79
Fabaceae	18	48
Cyperaceae	4	16
Scrophulariaceae	7	13
Solanaceae	4	13
Euphorbiaceae	4	13

TABLA 3. Géneros con mayor número de especies.

Genero	Especies	Genero	Especies
<i>Muhlenbergia</i>	15	<i>Dalea</i>	9
<i>Cyperus</i>	10	<i>Desmodium</i>	8
<i>Euphorbia</i>	10	<i>Aristida</i>	8
<i>Quercus</i>	9		

NOTA: Los números de colecta en su totalidad y los que no estan precedidos por abreviaturas de herbario, son ejemplares que se encuentran depositados en el herbario de la Facultad de Ciencias Forestales, Universidad Autónoma de Nuevo León.

LISTA DE LAS PLANTAS VASCULARES DE LA LAGUNA DE BABICORA

POLYPODIOPHYTA

ADIANTHACEAE

- Astrolepis sinuata* Hook (Lag. ex Swartz) Benham & Winham
Boemmeria hispida (Mett.) Undew., EE 3041 NMC.
Cheilanthes alabamensis (Buckl.) Kunze, EE 3005 NMC; EE 3018 NMC
Cheilanthes villosa Maxon., EE 3011 NMC; EE 3418 NMC.
Cheilanthes wootoni Maxon, EE 3040 NMC.
Cheilanthes wrightii Hook., EE 3676 NMC.
Pellaea atropurpurea (L.) Link, EE 3074 NMC.

EQUISETACEAE

- Equisetum laevigatum* A. Braun, EE 2945 NMC, NY.

OPHIOGLOSSACEAE

- Ophioglossum engelmannii* Prantl., EE 3564A NMC.

POLYPODIACEAE

- Pleopeltis polylepis* (Kunze) T. Moore var. *erythrolepis* (Weatherby) T. Went, EE 3704 NMC, NY.

PINOPHYTA (Gimnospermas)

CUPRESSACEAE

- Junipreus deppeana* Steud, EE 2489, 3394 NY.

PINACEAE

- Pinus arizonica* Engelm., EE
Pinus ayacahuite Ehr. var. *brachyptera* Shaw, EE 3221a.
Pinus cembroides Zucc., EE 3452a.
Pinus chihuahuana Engelm. EE 2491.
Pinus engelmannii Carr., EE 3657.
Pseudotsuga menziesii (Mirb.) Franco, EE 3672.

MAGNOLIOPHYTA (Angiospermas)

MAGNOLIOPSIDA (Dicotiledóneas)

AMARANTHACEAE

- Amaranthus palmeri* S. Wats., EE 3272 NMC; EE 3515 BRIT, NMC, NY ; EE 3482 BRIT, NMC, NY; EE 3342 NMC; EE 3542 NMC; EE 3195 NMC; EE 3751 NMC.
Froelichia gracilis (Hook.) Moq., EE 3113 NY; EE 3127 NMC.
Gomphrena sonora Torr., EE 3341 NMC, NY.
Guilleminia densa (Willd.) Moq., EE 3486 NMC, NY.
Gossypianthus lanuginosus (Poir.) Moq. var. *lanuginosus* , EE 3335 NMC, NY.
Tidestromia lanuginosa (Nutt.) Standl. var. *lanuginosa*, EE 3391 NMC, NY.

ANACARDIACEAE

- Rhus trilobata* Nutt. ex Torr. & A. Gray var. *pilosissima* Engler in DC., EE 3020; EE 3361 NMC, NY.

APIACEAE

- Daucus montana* Humb. & Bonpl., EE 3742 NMC.
Eryngium lemmonii Coult. & Rose, EE 3016 NMC.
Eryngium heterophyllum Engelm., EE 3396 NMC, NY; EE 3290 BRIT, NY; EE 3134.
Prinosciadium madrense S. Wats., EE 3058 NMC.

ASCLEPIADACEAE

- Asclepias contrayerba* Sesse & Moc., EE 3140 NMC.
Asclepias subverticillata (A. Gray) Vail, EE 3505 BRIT, NMC, NY.
Matelea chihuahuensis A. Gray EE 3206a NMC.

ASTERACEAE

- Achillea millefolia* L. EE 3338 NMC, NY, TEX; EE 3407 TEX.
Ageratina herbacea (A. Gray) Greene, EE 3707 NMC, NY, TEX.
Ageratina byssopina (A. Gray) King & Rob., EE 3724 NMC, NY, TEX.

- Ageratina rothrockii* (Gray) King & Rob., EE 3705 TEX.
- Ambrosia canescens* A. Gray, EE 3292 BRIT, NMC, NY, TEX.
- Ambrosia psilostachya* DC., EE 3627a TEX; EE 3349 TEX; EE 3482a TEX; EE 3484; EE 3641 TEX; EE 3267a; EE 3779 TEX.
- Artemisia dracunculus* var. *glauca* (Pall.) Munz, EE 3672 NMC, NY, TEX.
- Artemisia ludoviciana* Nutt., EE 3095 TEX; EE 3712 NMC, NY, TEX.
- Aster subulatus* var. *parviflorus* (Nees) Sundberg, EE 3269 NMC, NY, TEX; EE 3294 TEX; EE 2920 NMC, NY, TEX.
- Bidens aurea* (Ait) Sherff, EE 3068, 3228a TEX; EE 3518 BRIT, NMC, NY, TEX; EE 3518a; EE 3533; EE 3549 TEX.
- Bidens lemmonii* A. Gray, EE 3592 NMC, NY, TEX.
- Bidens leptcephala* Sherff, EE 3669 NY, TEX.
- Bidens odorata* Cav. var. *odorata* Gray, EE 3252 TEX; EE 3258 TEX; EE 3259; EE 3311 NMC, NY, TEX; EE 3375 TEX; EE 3399 TEX.
- Brickellia betonicifolia* Gray, EE 3560 BRIT, NMC, NY, TEX.
- Brickellia eupatorioides* var. *chlorolepis* (Woot. & Standl.) Shinnars, EE 3620 TEX; EE 3431 TEX; EE 3620 NMC, NY, TEX.
- Brickellia rusbyi* A. Gray, EE 3692 BRIT, NMC, NY, TEX.
- Brickellia simplex* A. Gray, EE 3563 NMC, NY, TEX.
- Carpochaete pringlei* (S. Wats.) Grashoff ex. B. Turner var. *pringlei* EE 3470 NMC, NY, TEX.
- Centaurea americana* Nutt., EE 3678 BRIT, NMC, NY, TEX.
- Cirsium ochrocentrum* A. Gray, EE 3350 BRIT, NMC, NY, TEX; EE 3395 TEX.
- Conyza canadensis* (L.) Cronq., EE 3313 NY, TEX; EE 3523 TEX.
- Cosmos parviflorus* (Jacq.) Pers., EE 3253 TEX; EE 3256 TEX; EE 3260 TEX; EE 3381 TEX; EE 3427 NMC, TEX; EE 3607a TEX; EE 3616 TEX.
- Cosmos palmeri* B.L. Rob., EE 3444 TEX.
- Cosmos pringlei* B.L. Rob. & Fern., EE 3573 TEX.
- Dahlia coccinea* Cav., EE 3015 TEX.
- Erigeron coronarius* Greene, EE 3326 BRIT, NMC, NY, TEX; EE 3406 TEX; EE 3457.
- Erigeron fraternus* E. Greene, EE 2942 TEX.
- Erigeron neomexicanus* Gray, EE 3038 TEX.
- Erigeron oreophilus* Greenm., EE 3625 NMC, TEX.
- Erigeron strigosus* Greene, EE 3789 TEX; EE 3790 TEX; EE 3706 NY, TEX.
- Erigeron versicolor* (Greenm.) Nesom, EE 3263 NMC, TEX; EE TEX; EE 3457a TEX; EE 3498 TEX.
- Erigeron wislizeni* (A. Gray) Greene, EE 3436 TEX; EE 3601 BRIT, TEX, NMC; EE 3373 NY, TEX.
- Gaillardia pinnatifida* Torr., EE 3122 BRIT, NMC, NY, TEX.
- Galinsoga parviflora* Cav. var. *parviflora*, EE 3312 NY, TEX; EE 3475 TEX.
- Galinsoga parviflora* Cav. var. *semicalva* A. Gray, EE 3640 TEX.
- Gnaphalium* aff. *arizonicum* A. Gray, EE 3002 TEX; EE 3190 NMC, NY, TEX; EE 3293 NMC, NY, TEX.
- Gnaphalium viscosum* Kunth, EE 3129 NMC, NY, TEX; EE 3327 TEX; EE 3404 TEX.
- Gnaphalium* sp., EE 3708 TEX.
- Grindelia confusa* Steyerl., EE 3316 TEX.
- Guardiola arguta* (A. Gray) B.L. Rob., EE 3078 NY, TEX; EE 3756 NMC, TEX.
- Gutierrezia conoidea* (Hemsl.) M. Lane, EE 3257 NMC, NY, TEX.
- Gutierrezia wrightii* A. Gray, EE 3595 TEX; EE 3185 NMC, TEX.
- Helenium chihuahuense* Bierner, EE 3287 NY, TEX; EE 3501 NY, TEX.
- Heterosperma pinnatum* Cav., EE 3066, 3241 TEX; EE 3476 NMC, NY, TEX.
- Hieracium carneum* Greene, EE 3609 TEX; EE 3572 TEX; EE 3571 TEX.
- Hieracium pringlei* A. Gray EE 3164 TEX.
- Hydropectis estradii* B.L. Turner, EE 3499 NMC, NY, TEX.
- Hymenopappus mexicanus* Gray, EE 3709 TEX.
- Hymenothrix palmeri* A. Gray, EE 3693 BRIT, NMC, NY, TEX.
- Lactuca serriola* L., EE 3517 NY; EE 3617a TEX.

Laennecia schiediana (Less.) Nesom (= *Conyza schiedeana* (Less.) Cronq.), EE 3645 NMC, TEX; EE 3138 TEX.

Laennecia sophiaefolia (Kunth) Nesom (= *Conyza sophiifolia* Kunth) ., EE 3179 NY, TEX; EE 3247 NMC, NY, TEX; EE 3138 TEX.

Lasianthaea podocephala (A. Gray) Benth., EE 3056 TEX.

Leibnitzia lyrata (D. Don) Nesom, EE 2939 TEX; EE 3659 NMC, TEX.

Machaeranthera gracilis (Nutt.) Shinnery, EE 3405A TEX; EE 3353 NMC, NY, TEX.

Melampodium strigosum Stuessy, E 3343 TEX; EE 3464 TEX.

Pectis prostrata Cav., EE 3090 TEX.

Psilactis asterioides A. Gray, EE 3288 NY; EE 3524 TEX.

Ratibida mexicana (Wats.) Sharp, EE 3681 TEX.

Schckburia pinnata (Lam.) Kuntze var. *guatemalensis* (Rydb.) McVaugh, EE 3281 BRIT, NMC, NY, TEX; EE 3449a TEX; EE 3477 NMC, NY, TEX; EE 3534 NMC, NY, TEX; EE 3539; EE 3540 TEX; EE 3643 TEX.

Senecio flaccidus Less. var. *flaccidus*, EE 3365 NMC, NY, TEX.

Senecio octobracteatus Barkley & Turner, EE 2927 NY, TEX.

Simsia amplexicaulis (Sims) Pers., EE 3389 NMC, NY, TEX; EE 3459 TEX; EE 3511 NMC, NY, TEX; EE 3516 NMC, NY, TEX.

Stevia plumeriae Gray var. *plumeriae*, EE 3761 TEX; EE 3167 TEX; EE 3575 TEX.

Stevia serrata Cav. var. *serrata*, EE 3055 TEX; EE 3240 NY, TEX; EE 3215 TEX.; EE 3723 TEX.

Stevia viscida Kunth, EE 3469 NMC, NY, TEX; EE 3557 NMC; EE 3791 TEX.

Tagetes lucida Cav., EE 3135 TEX.

Tagetes micrantha Cav., EE 3284 BRIT, NMC, NY, TEX.

Tagetes pringlei A. Gray, EE 3538 NMC, NY, TEX; EE 3739 TEX.

Taraxacum officinale L., EE 3355a NY.

Tithonia tubiformis (Jacq.) Cass., EE 3445 NMC; EE 3504 TEX; EE 3525 TEX.

Tragopogon porrifolius L., EE 3283 TEX; EE 3579 NMC, NY, TEX.

Verbesina longifolia Gray, EE 3446 NMC, NY, TEX; EE 3673 NMC, NY, TEX.

Verbesina parviflora (H.B.K.) Blake, EE 3079 TEX.

Viguiera cordifolia Gray var. *cordifolia*, EE 3696 BRIT, NMC, NY, TEX.

Viguiera decurrens A. Gray, EE 3085 TEX.

Viguiera multiflora (Nutt.) Blake, EE 3282 TEX; EE 3315 TEX.

Xanthium strumarium L., EE 3528 NMC, NY.

Xanthocephalum gymnospermoides (A. Gray) Benth., EE 3295 NMC, NY, TEX.

Zinnia tenuis (S. Wats.) Strother, EE 3480 NMC, NY, TEX; EE 3686 TEX.

BORAGINACEAE

Amsinckia micrantha Susk., EE 3362 NMC, NY.

Heliotropium curassavicum L. var. *curassavicum*, EE 3231 NMC, NY; EE 3728 BRIT, NMC, NY.

Lithospermum multiflorum Gray, EE 3249 NMC.

Lithospermum cobrense Greene, EE 3249a NMC.

BRASSICACEAE

Brassica campestris L., EE 3271 BRIT, NMC, NY.

Brassica rapa L., EE 3483 NMC.

Descurainia impatiens (Cham. & Schlecht.) Schulz. EE. 3792 TEX

Descurainia pinnata (Walt.) Brit. var. *pinnata*, EE 2492.

Draba petrophylla Greene, EE 3671 NMC, NY.

Lepidium sordidum L., EE 3289 NMC.

Lepidium virginicum L., EE 3685 NMC.

Penellia longifolia Benth., EE 2999, 3168 NMC, NY; EE 3670 NMC; EE 3766 NMC.

Pennellia micrantha (Gray) Nieuwl., EE 3325 NMC.

Sisymbrium linearifolium Nutt., EE 3358 NMC.

Sisymbrium sp., EE 3360.

CACTACEAE

Echinocereus polyacanthus Engelm., EE. 4241.
Mammillaria sp. EE. 4244.

CAMPANULACEAE

Lobelia anatina E. Wimm, EE 3460 NMC, NY, BRIT, TEX; EE 3762 NMC; EE 3621 BRIT, NMC, NY.
Lobelia fenestralis Cav., EE 3139 NMC; EE 3296 NMC; EE 3403 TEX.

CARYOPHYLLACEAE

Arenaria bourgaei Hemsl., EE 3503 BRIT, NMC, NY.
Arenaria lanuginosa (Michx.) Rohrb., EE 3104 NMC, NY.
Cerastium nutans Raf., EE 2948 BRIT, NMC, NY; EE 3652 BRIT, NMC, NY, TEX.
Corrigiola andina Tr. & Planch., EE 3340 NMC, NY.
Drymaria leptophylla (Cham. & Schlecht.) Fenzl., EE 3145 BRIT, NMC, NY; EE 3212 NMC; EE 3711 NMC, NY.
Drymaria molluginea (Lag.) Didr., EE 3157 NMC, NY.
Silene laciniata Cav. var. *laciniata*, EE 2947 NY; EE 3661 BRIT, NMC, TEX.
Silene scouleri Hook. var. *pringlei* (Wats.) Hitchc., EE 3574 BRIT, NMC, NY.

CHENOPODIACEAE

Atriplex texana S. Wats., EE 3730 BRIT, NMC, TEX.
Chenopodium album L., EE 3123 BRIT, NMC, NY; EE 3270 NY; EE 3522 NMC, NY.
Chenopodium berlandieri Moq., EE 3726 NMC, NY.
Chenopodium graveolens Willd., EE 3628 NY; EE 3755 NY.
Chenopodium incisum Poir., EE 3124 NMC, NY.
Salsola tragus L., EE 3392 NY.

CISTACEAE

Helianthemum glomeratum (Lag.) Dun., EE 3378 NMC, NY.
Helianthemum pringlei S. Wats., E 3380 NMC.

CONVOLVULACEAE

Convolvulus equitans Benth., EE 3328 NMC, NY.
Evolvulus sericeus Sw. EE 3329 BRIT, NMC, NY.
Ipomoea capillacea (H.B.K.) G. Don, EE 3317 NMC, NY; EE 3462 NY.
Ipomoea costellata Torr., EE 3161 NMC, NY; EE 3200 NMC, NY.
Ipomoea lindheimieri Gray, EE 3569 BRIT, NMC, NY.
Ipomoea hirsutula Jacq., EE 3536 NMC, NY.
Ipomoea madrensis S. Wats., EE 3072; EE 3150 NMC.
Ipomoea pubescens Lam., EE 3351 NY.
Ipomoea tenuiloba Torr., EE 3032 NMC.

CRASSULACEAE

Sedum alamosanum M.E. Jones, EE 3042.

CUCURBITACEAE

Sicyos laciniatus L., EE 3725 BRIT, NMC, NY, TEX; EE 3236 NMC.
Cucurbita foetidissima H.B.K., (obs. pers.).

CUSCUTACEAE

Cuscuta applanata Engelm., EE 3547, 3126 NMC.

ERICACEAE

Arbutus xalapensis H.B.K., EE 3059; EE 2496.
Arctostaphylos pungens H.B.K., EE 3152 NY.
Monotropa latisquama (Rydb.) Hult., EE 2949.

EUPHORBIACEAE

Acalypha neomexicana Muell., EE 3172 NMC, NY; EE 3205 NMC, NY; EE 3319 NY.
Chamaesyce serphyllifolia (Pers.) Small, EE 3379 BRIT, NMC; EE 3530 NMC, NY, TEX; EE 3028.
Euphorbia barrancana Mayfield & Steinm., EE 3440 NY, TEX.
Euphorbia cuphosperma Boiss., EE 3387 NMC.
Euphorbia dentata Michx., EE 3242 BRIT, NMC, NY.

Euphorbia heterophylla L., EE 3776 NMC.
Euphorbia hexagona Nutt., EE 3596.
Euphorbia macropus (Kl. & Gke.) Boiss., EE 3384 NMC, TEX.
Euphorbia nutans Lag., EE 3183 NMC.
Euphorbia sphaerorbiza Benth., EE 3320 BRIT, NMC, NY; EE 3596a NMC.
Euphorbia villifera Scheele, EE 2925 NMC, NY; EE 3417 NMC.
Euphorbia aff. *xalapensis* Kunth, EE 3321 TEX.
Tragia ramosa Torr., EE 3337 NY.

FABACEAE

Astragus giganteus Wats., EE 3229 NY; EE 3428 NMC, NY; 3526 BRIT, NMC, NY.
Astragalus humistratus Gray var. *humistratus*, EE 3551 BRIT, NMC, NY.
Astragalus longissimus (M.E. Jones) Barneby, EE 3433 NY.
Astragalus scalaris Wats., EE 2929 NMC, NY.
Astragalus vaccarum Gray, EE 2928 NMC, NY; EE 3224 BRIT, NMC, NY.
Cologania angustifolia H.B.K., EE 3057 TEX; EE 3151 NY; EE 3376, 3408 NY.
Cologania obovata Schlecht., EE 3049, 3644 NY; EE 3767 NY; EE 3069, 3442.
Crotalaria polyphylla Riley, EE 3050; EE 3412 NY; EE 3606 NY; EE 3757 NY; EE 3197 NMC, NY, TEX.
Crotalaria rotundifolia (Walt.) Gmelin var. *vulgaris* Grear, EE 3160 NY; EE 3412.
Coursetia glabella (Gray) Lavin, EE 3082 NY; EE 3177 NY; EE 3211 NY; EE 3454 BRIT, NMC, NY.
Dalea albiflora Gray, EE 3128 NMC, NY; EE 3582 NMC, NY; EE 3622 BRIT, NMC, NY, TEX; EE 3733 NMC, NY.
Dalea exigua Barneby, EE 3154 NY; EE 3201 NMC, NY; EE 3584 BRIT, NMC, NY; EE 3760 NY.
Dalea filiformis Gray, EE 3186 NY; EE 3206 BRIT, NMC, NY; EE 3479 NMC, NY, BRIT; EE 3583 NMC, NY; EE 3736 BRIT, NMC, NY.
Dalea grayi (Vail) L.O. Williams, EE 3044; EE 3561 BRIT, NMC, NY; EE 3574 NY.
Dalea leporina (Aiton) Bullock, EE 3535

NMC, NY; EE 3778 NY; EE 3453 NY.
Dalea obreniformis (Rydb.) Barneby, EE 3613 BRIT, NMC, NY; EE 3775 NY.
Dalea polygonoides A. Gray, EE 3193 NY; EE 3216 NY; EE 3694 NY; EE 3740 NY; EE 3777 NY.
Dalea reclinata (Cav.) Willd., EE 3614 BRIT, NMC, NY; EE 3735 BRIT, NMC, NY.
Dalea urceolata Greene var. *urceolata*, EE 3615 NY.
Desmodium arizonicum S. Wats., EE 3710 NMC, NY.
Desmodium batocaulon Gray, EE 3025 TEX.
Desmodium grahamii Gray, EE 3012; EE 3043 TEX; EE 3196 NMC, NY, TEX; EE 3390 NY, TEX; EE 3597 NY; EE 3715 TEX.
Desmodium hartwegianum Hemsl. var. *hartwegianum*, EE 3045, EE 3153 NY; EE 3590 NY.
Desmodium madreense Hemsl., EE 3455 NMC, NY, TEX.
Desmodium neomexicanum Gray, EE 3424 BRIT, NMC, NY, TEX; EE 3115 NMC, NY, TEX; EE 3254 NY; EE 3388 NY, TEX; EE 3688 NMC, NY; EE 3753 NMC, NY; EE 3773 BRIT, NMC, NY, TEX.
Desmodium retinens Schlecht., EE 3393 BRIT, NMC, NY, TEX.
Desmodium sp., EE 3423 NY, TEX; EE 3054 TEX; EE 3021 TEX.
Indigofera montana Rose, EE 4243.
Lathyrus graminifolius (Walt.) White, EE 3562 BRIT, NMC, NY.
Lotus chihuahuensis (Wats.) Greene, EE 3071.
Lotus oroboides (H.B.K.) Ottley ex Kearney & Peebles, EE 2935 NY; EE 3425 NY; EE 3070.
Lupinus barberi C.P. Smith, EE 3063 TEX; EE 3262 NY, TEX; EE 3422 NMC, TEX; EE 3697 NY, TEX; EE 3145 BRIT, NMC, NY, TEX.
Lupinus aff. *barberi* C.P. Smith, EE 3184 NMC, TEX; EE 3209 BRIT, NMC, NY, TEX; EE 3441 BRIT, NMC, NY, TEX.
Macroptilium gibossifolium (Ort.) Delgado, EE 3369 NMC, NY; EE 3347 NY.
Medicago sativa L., EE 3353.
Medicago lupulina L. (observ. pers.).

Minklersia galactoides Mart. & Gal., EE 3608
BRIT, NMC, NY, TEX.

Phaseolus parvulus Greene, EE 3051; EE
3210; EE 3212a BRIT, NMC, NY, TEX;
EE 2856 TEX.

Phaseolus pedicelatus Benth. var. *grayanus*
Woot. & Standl., EE 3383 NY, TEX; EE
3447 TEX; EE 3064.

Phaseolus ritensis Jones, EE 2852 NY.

Phaseolus vulgaris L., EE 3264 NY.

Rhynchosia macrocarpa Benth., EE 3359
BRIT, NMC, NY.

Sophora nuttalliana Turner, EE 3235 NY.

Trifolium amabile H.B.K. var. *amabile*, EE
3602 NY; EE 3223.

Trifolium amabile H.B.K. var. *longifolium*
Hemsl., EE 3331 NY; EE 3409 NMC,
NY, BRIT; EE 3495 NMC, NY, BRIT;
EE 3738 BRIT, NMC, NY.

Trifolium wormskioldii Lahm. var. *ortegae*
(Greene) Barneby, EE 3314 BRIT, NY.

Vicia pulchella H.B.K. ssp. *mexicana* (Hemsl.)
C.R. Gunn, EE 3500 NMC, NY, TEX;
EE 3550 BRIT, NMC, NY.

Vicia pulchella H.B.K. ssp. *pulchella*, EE 2936
NY; EE 3214 NMC, NY; EE 3695
NMC, NY; EE 3103 NY.

Zornia reticulata Sm., EE 3453 BRIT, NMC,
NY.

FAGACEAE

Quercus arizonica Sarg., EE 3024; EE 3439
BRIT, NMC, NY.

Quercus depressipes Trel., EE 3702 BRIT,
NMC, NY; EE 3716 BRIT, NMC, NY;
EE 3720 NMC, NY.

Quercus emoryi Torr., EE 3471 BRIT, NMC,
NY.

Quercus gambelii Nutt., EE 2934 NMC, NY;
EE 3687 BRIT, NMC, NY.

Quercus grisea Liebm., EE 3472 BRIT, NMC,
NY; EE 3700 NMC; EE 3701 BRIT,
NMC, NY.

Quercus hypoleucoides A. Camus, EE 3023; EE
3474 NMC, NY.

Quercus mcvaughii Spellenberg, EE 3237
NMC; EE 3438 BRIT, NMC, NY; EE
3468 NMC, NY, BRIT; EE 3627 NMC,
NY.

Quercus rugosa Nee, EE 2490; EE 3626
NMC.

Quercus sideroxyla Humb. & Bonpl., EE 3088
BRIT, NMC, NY.

GENTIANACEAE

Gentiana amarella (L.) Boerner, EE 3677
BRIT, NMC, NY, TEX.

GERANIACEAE

Erodium cicutarium (L.) L. H'er, EE 2494; EE
3339 NY.

Geranium atropurpureum Heller, EE 3244
NMC, NY; EE 3381 NMC; EE 3684
NMC; EE 3656 BRIT, NMC, NY.

Geranium niveum S. Wats., EE 3771 NMC;
EE 3619 NY.

Geranium richardsonii James, EE 3787 NMC,
NY, TEX.

Geranium subulato-stipulatum Kunth, EE
3679 NMC, NY; EE 3774 NMC, NY;
EE 3783 NMC.

Geranium wislizeni Wats., EE 3006, EE 3099
NMC; EE 3220 NMC, NY.

GUTIFERAE

Hypericum pauciflorum H.B.K., EE 3578
NMC, NY.

HYDRANGEACEAE

Philadelphus microphyllus A. Gray, EE 3662
BRIT, NMC, NY.

HYDROPHYLLACEAE

Nama dichotomum (Ruiz & Pavón) Choisy, EE
3118 NY, TEX.

LAMIACEAE

Agastache pallida (Lindl.) Cory var. *coriacea*
R.W. Sanders, EE 3091 BRIT, NMC,
NY; EE 3187 BRIT, NY.

Hedeoma oblongifolium (Gray) Heller var.
mexicanum Irving, EE 3178 BRIT, NMC,
NY; EE 3092 NMC, NY.

Monarda austromontana Epling, EE 3255
NY; EE 3084 BRIT, NY.

Salvia prunelloides H.B.K., EE 3166 NMC,
NY.

Salvia reflexa Hornem, EE 3732 BRIT, NMC, NY, TEX.

Salvia tiliaefolia Vahl., EE 3731 BRIT, NMC, NY, TEX; EE 3426 NMC, NY.

Salvia sp., EE 3213 BRIT, NMC, NY.

Stachys coccinea Jacq., EE 3576 BRIT, NMC, NY.

LINACEAE

Linum aristatum Engelm., EE 3158 NMC.

Linum sp., EE 3600 NMC.

MALVACEAE

Anoda cristata (L.) Schlecht., EE 3230; EE 3385 NMC, NY, 3510 BRIT, NMC, NY; EE 3387a NMC.

Malva neglecta Wallr., EE 3278 NY; EE 3532 BRIT, NMC, NY.

Sida neomexicana Gray, EE 3411 NMC.

Sidalcea neomexicana A. Gray, EE 3291 BRIT, NMC, NY; EE 3610.

Sphaeralcea angustifolia (Cav.) Don var. *angustifolia*, EE 3137 BRIT, NMC, NY.

Sphaeralcea fendleri Gray, EE 3529 NMC; 2507.

MIMOSACEAE

Acacia angustissima (P. Miller) Kuntze var. *texensis* (Torr. & Gray) Isely, EE 3363 NY.

Calliandra humilis Benth., EE 3463 BRIT, NMC, NY; EE 3623.

Calliandra reticulata Gray, EE 3007, EE 3344 NY; EE 3581 NY.

Mimosa dysocarpa Benth., EE 3368 BRIT, NMC, NY.

NYCTAGINACEAE

Mirabilis longiflora L., EE 3033 NMC.

Mirabilis multiflora (Torr.) Gray, EE 3117 BRIT, NMC, NY.

Mirabilis oblongifolia Heimerl, EE 3169 BRIT, NMC, NY; EE 3698 NMC.

OLEACEAE

Fraxinus velutina Torr., EE 3437 NMC, NY.

ONAGRACEAE

Epilobium ciliatum Raf., EE 3274 BRIT, NMC, NY.

Gaura coccinea Pursh., EE 3047 TEX; EE 3366 NMC; EE 3448 TEX; EE 3588 NY, TEX; EE 3653 TEX; 3397 TEX.

Gaura hexandra Gómez Otrera ssp. *gracilis* (Woot. & Standl.) Raven & Gregory, EE 3136 NMC, NY, TEX.

Lopezia gracilis Wats., EE 3637 NMC, NY.

Oenothera brachycarpa Gray, EE 3497 TEX.

Oenothera laciniata Hill ssp. *laciniata*, EE 3094 NMC; EE 3553 NMC; EE 3703 NMC; EE 3181; EE 3449 NY, TEX.

OXALIDACEAE

Oxalis alpina (Rose) Kunth, EE 3222.

Oxalis corniculata L., EE 3741 NY; EE 3651 NMC, NY; EE 3336 NY.

Oxalis decaphylla H.B.K., EE 3217 NMC, NY; EE 3221.

Oxalis drummondii Gray, EE 3268 NMC.

PLANTAGINACEAE

Plantago australis Lam., EE 2922 NMC.

Plantago hirtella H.B.K., EE 3630 NMC, NY.

Plantago linearis H.B.K. var. *mexicana* (Link) Pilger, EE 3246 BRIT, NMC, NY, TEX.

Plantago patagonica Jacq., EE 3456 NMC.

POLEMONIACEAE

Ipomopsis pinnata (Cav.) V. Grant, EE 3793 TEX; EE 3377 NMC; EE 3719 NMC, NY.

Ipomopsis thurberi (Gray) V. Grant, EE 3432 BRIT, NMC, NY.

Ipomopsis sp., EE 3065.

Phlox nana Nutt., EE 3346 NMC.

POLYGALACEAE

Moninna wrightii A. Gray, EE 3027; EE 3180 NY; EE 3605 NMC, NY.

Polygala alba Nutt., EE 2519; EE 3132 NY.

Polygala obscura Benth., EE 3587 NMC; EE 3593 NMC, NY.

Polygala tweedyi Britt., EE 3364 NMC, NY.

POLYGONACEAE

Eriogonum atrorubens Engelm., EE 3352 NMC.

Polygonum aviculare L., EE 3277 BRIT, NMC, NY; EE 3531 BRIT, NMC, NY.

Polygonum lapathifolium L., EE 3307a BRIT, NMC, NY.

Polygonum pensilvanicum L., EE 3548 NY.

Polygonum sp., EE 3140a.

Rumex acetosella L., E 3646 BRIT, NY.

Rumex mexicanus Meisn., EE 3307 NMC, NY; EE 3280 NMC; EE 3280a NMC.

Rumex sp., EE 3650 NY.

PORTULACACEAE

Portulaca oleracea L., EE 3273 NMC.

RANUNCULACEAE

Aquilegia skinneri Hook., EE 3674 BRIT, NMC, NY, TEX.

Delphinium andesicola Ewan, EE 2943 NMC.

Ranunculus sp., EE 3617 NMC.

Thalictrum pinnatum Wats., EE 3682; EE 3382 NMC, NY.

RHAMNACEAE

Ceanothus fendleri Gray var. *venosus* Trel., EE 3000; EE 3060; EE 3093a NMC, NY; EE 3372 NY.

ROSACEAE

Alchemilla aphanoides L., EE 3304 BRIT, NMC, NY.

Cercocarpus montanus Raf. var. *paucidentatus* (Wats.) F.L. Martin, EE 3022.

Holodiscus discolor (Pursh) Maxim., EE 3691 BRIT, NMC, NY, TEX.

Potentilla anserina L., EE 3227 BRIT, NMC, NY; EE 3521 BRIT, NY.

Potentilla thurberi Gray, EE 3461 NMC.

Potentilla sp., EE 2495; EE 2518.

Prunus serotina Ehrh. EE 4242.

Rosa sp., EE 2932 NY, NMC.

RUBIACEAE

Bouvardia ternifolia (Cav.) Schlecht., EE 3052.

Crusea diversifolia (H.B.K.) Anderson, EE 3466 NY.

Crusea longiflora (Willd. ex Roem & Shult.) Anderson, EE 3478 BRIT, NMC, NY.

Galium mexicanum H.B.K. var. *asperulum*

(Gray) Dempst., EE 2944 NMC, NY; EE 3668 BRIT, NMC, NY.

Galium microphyllum Gray, EE 3004.

Sherardia arvensis L., EE 3108 NY; EE 3208 NY; EE 3318 NMC, NY; EE 3400 NY; EE 3647 NY.

SALICACEAE

Populus tremuloides Michx., EE 2933 NMC, NY; EE 3658 NMC, NY.

Salix lasiolepis Benth. (obs. pers.).

SAXIFRAGACEAE

Heuchera sanguinea Engelm., EE 3030.

SCROPHULARIACEAE

Castilleja patriotica Fern., EE 2941 NMC, NY; EE 3683 TEX.

Castilleja tenuiflora Benth., EE 3717 BRIT, NMC, NY, TEX; EE 3794 TEX.

Castilleja sp., EE 3080 NMC.

Mecardonia vendellioides (H.B.K.) Pennell, EE 3416 BRIT, NMC, NY.

Mimulus guttatus Fisch ex DC., EE 2924 NY; EE 3772a NMC.

Penstemon barbatus (Cav.) Roth., EE 3076 NMC, NY; EE 3188 NMC, NY; EE 3251 NMC.

Penstemon campanulatus (Cav.) Willd. ssp. *chihuahuensis* Straw, EE 3077 NMC, NY; EE 3165 NMC; EE 3250 BRIT, NMC, NY.

Penstemon lanceolatus Benth., EE 3251 NMC, NY.

Penstemon miniata Lindl. ssp. *apateticus* (Straw) Straw, EE 3419 BRIT, NMC, NY.

Penstemon stenophyllus Gray, EE 3010; EE 3570; EE 3603 NMC.

Schistophragma intermedia (A. Gray) Pennell, EE 3112 NMC.

Seymeria bipinnatisecta Seem., EE 3062; EE 3374 BRIT, NMC, NY.

Veronica mexicana S. Wats., EE 2940 NMC, TEX.

SOLANACEAE

Datura quercifolia H.B.K., EE 3125 NMC, NY.

Petunia parviflora Juss., EE 3228 BRIT, NMC, NY.

Physalis caudella Standl., EE 3075 NMC, NY.

Physalis hederæfolia Gray var. *hederæfolia*, EE 3355; EE 3204 NMC, NY, TEX.

Physalis hederæfolia Gray var. *puberula* Gray, EE 3402 NMC.

Physalis pubescens L., EE 3265.

Physalis pubescens L. var. *pubescens*, EE 3171 BRIT, NMC, NY.

Physalis subulata Rydb. var. *subulata*, EE 3182 BRIT, NMC, NY.

Physalis sulphurea (Fernald) Waterfall, EE 3226; EE 3527 BRIT, NMC, NY; EE 3750 NY; EE 3230 NY.

Physalis sp., EE 3401 NMC, NY.

Solanum citrullifolium A. Br., EE 3266 BRIT, NMC, NY.

Solanum fendleri A. Gray, EE 3061; EE 3649 NMC; EE 3105 NMC; EE 3218 NMC; EE 3386.

Solanum nigrescens Mart. & Gal., EE 3001; EE 3191 BRIT, NMC, NY.

Solanum rostratum Dunal, EE 3334 NMC, NY.

Solanum sp., EE 3086 NMC.

ULMACEAE

Ulmus americana L., EE 2493 (cultivado).

URTICACEAE

Urtica chamaedryoides Pursh, EE 3780 BRIT, NY.

VALERIANACEAE

Valeriana edulis Nutt., EE 3655 BRIT, NMC; EE 3665 NMC.

Valeriana sorbifolia Kunth, EE 2950 NY, TEX; EE 3648 BRIT, NMC, NY, TEX.

VERBENACEAE

Verbena bipinnatifida Nutt., EE 3100 BRIT, NMC; EE 3330 NY; EE 3494 NY.

Verbena gracilis Desf., EE 3285 BRIT, NMC, NY.

Verbena neomexicana (Gray) Small var. *xylopoda* Perry, EE 3146 BRIT, NMC, NY; EE 3589 NY; EE 3202 NMC, NY.

Verbena caroliniana L., EE 3734 NMC.

Verbena sp., EE 3788 NMC.

VIOLACEAE

Viola umbraticola H.B.K., EE 3004, 3586 NY.

VISCACEAE

Arceuthobium vaginatum (Willd.) Presl., EE 3081 NMC, NY.

Phoradendron juniperinum Gray, EE 3690 BRIT, NMC, NY.

Phoradendron villosum (Nutt.) Nutt., EE 3468a BRIT, NMC, NY.

VITACEAE

Vitis arizonica Engelm. EE. 4241

LILIOPSIDA (Monocotiledoneas)

AGAVACEAE

Manfreda singuliflora (S. Wats.) Rose, EE 3718 NMC.

Agave parryi Engelm. var. *parryi*, EE 3718A.

AMARYLLIDACEAE

Hypoxis hirsuta (L.) Cav., EE 3048 TEX, NMC.

Hypoxis mexicana Schult., EE 3452 NMC, NY, TEX; EE 3580 BRIT, NMC, NY.

COMMELINACEAE

Commelina dianthifolia Del., EE 3473 TEX; EE 3473a TEX; EE 3758 TEX; EE 3163 NMC; EE 3194 NMC; EE 3443 NMC.

Commelina erecta L., EE 3323 NMC; EE 3568 BRIT, NMC, NY; EE 3604 NMC, NY; EE 3607 NMC.

Gibasis pulchella (Kunth) Rafin, EE 3458 TEX; EE 3481 NMC, NY, TEX; EE 3302 NMC, NY, TEX; EE 3772 NMC; EE 3207 NMC; EE 3156a NMC.

Tradescantia pinnetorum Greene, EE 3009 NMC; EE 3473 NY.

CYPERACEAE

Carex leucodonta Holm., EE 3199 TEX.

Cyperus esculentus L., EE 3502 NMC.

- Cyperus fendlerianus* Boeck., EE 3037 NMC; EE 3101 NMC, NY; EE 3176 NMC.
Cyperus flavicomus Michx., EE 3465 NMC, NY; EE 3591 NMC; EE 3008 NMC.
Cyperus fugax Liebm., EE 2926 NMC, NY; EE 3631 NMC.
Cyperus odoratus L., EE 3192a NMC; EE 3144 NMC.
Cyperus rotundus L., EE 3175 NMC, NY; EE 3303 NMC.
Cyperus sesslerioides H.B.K., EE 3110 NMC, NY; EE 3322 NMC, NY; EE 3198 NMC.
Cyperus sphaerolepis Boeck., EE 3155 NMC, NY; EE 3156; EE 3354 NMC, NY; EE 3689 NMC, NY.
Cyperus squarrosus L., EE 3632 NMC.
Cyperus sp., EE 3036; EE 3345 NY; EE 3413; EE 3722 NMC, NY.
Eleocharis macrostachya Britt., EE 3279 NMC, NY; EE 3310; EE 3304a NMC, NY.
Eleocharis aff. *montevidensis* Kunth, EE 3640 NY.
Eleocharis tenuis (Willd.) Schlecht., E 3102 NMC, NY.
Scirpus acutus Muhl., EE 2946 NMC, NY.

IRIDACEAE

- Sisyrinchium cernuum* (Bickn.) Kearney & Peebles, EE 3769 BRIT, NMC, NY, TEX; EE 3107 NY; EE 3170 NMC; EE 3634 NMC.
Sisyrinchium pringlei B.L. Rob. & Greenm., EE 3558a NMC.
Sisyrinchium scabrum Schlecht. & Cam., EE 3421 BRIT, NMC, NY.
Tigridia pavonia (L.F.) Ker., EE 3248; EE 3488; EE 3555 NMC.

JUNCACEAE

- Juncus marginatus* Rostk., EE 3309 NMC, NY, TEX.
Juncus nodosus L., EE 3275 NMC, TEX.
Juncus tenuis Willd., EE 3276 TEX; EE 3450 BRIT, NMC, NY, TEX.
Luzula parviflora (Ehrh.) Desv., EE 3663 BRIT, NMC, NY.

LILIACEAE

- Allium cernuum* Roth., EE 3664 BRIT, NMC, NY, TEX.
Allium glandulosum Link & Otto, EE 3031; EE 3332 BRIT, NY; EE 3594 NY.
Calochortus exilis Painter, EE 3261 BRIT, NMC, NY; EE 3420 BRIT, NMC, NY.
Calochortus sp., EE 3414 NY.
Ecceandria flavescens (Schltues & Schlutes) Cruden, EE 3053; EE 3173; 3243 NY; EE 3147 NMC, NY.
Milla biflora Cav., EE 3159 NY; EE 3286 NY; EE 3415 NMC, NY; EE 3642 NMC.
Zigadenus virescens (Kunth) Mcb., EE 3660 BRIT, NMC, NY, TEX.

ORCHIDACEAE

- Malaxis* sp., EE 3564 NMC.

POACEAE

- Aegopogon cenchroides* Humb. & Bonpl., EE 3577 NMC, NY.
Aegopogon tenellus (DC.) Trin., EE 2921 NMC, NY; EE 3633.
Aristida adscencionis L., EE 3367 NMC, NY.
Aristida affinis (Shult.) Kunth, EE 3106 NY.
Aristida barbata Fourn., EE 3786; EE 3491 NY; EE 3567 NMC, NY; EE 3026.
Aristida divaricata Willd., EE 3451 BRIT, NMC, NY; EE 3763 NMC.
Aristida hamulosa Henr., EE 3133 NMC, NY.
Aristida pansa Woot. & Standl., EE 3764 BRIT, NMC, NY.
Aristida wrightii Nash., EE 3106.
Bouteloua gracilis Lag., EE 3487 NY; EE 3785 NMC, NY.
Bouteloua hirsuta Lag., EE 3149; EE 3398 NY; EE 3142 NY.
Bouteloua simplex Lag., EE 3745; EE 3508 NY; EE 3490 NMC, NY; EE 3300 NY.
Bromus anomalus Rupr., EE 3089 NMC, NY; EE 3556 NMC, NY; EE 3189; EE 3119 NMC, NY, BRIT; EE 3680 NMC.
Bromus carinatus Hook. & Arn., EE 2937.
Bromus unioloides (Willd.) H.B.K., EE 2503.
Chloris gayana Kunth, EE 3485.

- Chloris submutica* H.B.K., EE 3333; EE 3301.
- Chloris virgata* Sw., EE 3599; EE 3513 NY.
- Deschampsia danthonioides* (Trin.) Munro ex Benth., EE 3324 NMC.
- Digitaria sanguinalis* (L.) Scop., EE 3109; EE 3729 NMC, NY; EE 3743
- Distichlis spicata* (L.) Greene var. *stricta* (Torr.) Beetle, EE 3507
NMC, NY; EE 3132 NY; EE 3752 NMC, NY.
- Echinocloa colonum* (L.) Link, EE 3545; EE 3308 BRIT, NMC, NY; EE 3737; 3180.
- Echinocloa crusgallii* (L.) Beauv., EE 3310a BRIT, NMC, NY; EE 3512.
- Echinocloa crusgavonis* (H.B.K.) Schult., EE 3544 NY.
- Eleusine multiflora* Hochst., EE 3192.
- Elyonurus barbiculmis* Hack., EE 3544.
- Elymus arizonicus* (Scribn. & Smith) Gould, EE 2931 NMC, NY; EE 3667, 3657.
- Elymus elymoides* (Raf.) Swezey, EE 3759; EE 3429 NY; EE 3130 NMC, NY.
- Elymus trachycaulus* (Link) Shinnars, EE 3306 NMC; EE 3699 NMC.
- Elytrigia repens* (L.) Nerski, EE 2930 NMC.
- Eragrostis mexicana* (Horn.) Link, EE 3612 NY; EE 3348 NY; EE 3727 NMC; EE 3297 NMC, NY; EE 3096 NMC, NY; EE 3496; EE 3116; EE 3721 NMC, NY.
- Eragrostis neomexicana* Vasey, EE 3784 NMC; EE 3120 BRIT, NMC, NY.
- Eragrostis pilosa* (L.) Beauv., EE 3509; EE 3514.
- Eragrostis* sp., EE 3744 NMC.
- Hackelochloa granularis* (L.) Kuntze, EE 3429a.
- Hordeum jubatum* L., EE 3305 NMC, NY.
- Leptochloa fascicularis* (Lam.) Gray, EE 3299 NMC.
- Leptochloa* sp., EE 3506 NMC, NY.
- Lycurus phleoides* H.B.K., EE 3747; EE 3245 BRIT, NMC, NY; EE 3371 BRIT, NMC, NY; EE 3782 NMC, NY.
- Muhlenbergia dubia* (Forn.) ex Hemsl., EE 3111 NMC, NY.
- Muhlenbergia emersleyi* Vasey, EE 3034.
- Muhlenbergia flavida* Vasey, EE 3493 BRIT, NY.
- Muhlenbergia leptoura* (Piper) Swallen, EE 3566 NY.
- Muhlenbergia macroura* (H.B.K.) Hitchc., EE 3298.
- Muhlenbergia minutissima* (Steud) Swallen, EE 2923 NMC; EE 3749; EE 3083 NMC, NY; EE 3098 NMC; EE 3635 NMC, NY.
- Muhlenbergia metcalfei* M.E. Jones, EE 3713 NMC, NY.
- Muhlenbergia montana* (Nutt.) Hitchc., EE 3748 BRIT, NMC.
- Muhlenbergia polycaulis* Scribn., EE 2938 NMC, NY; EE 3714 BRIT, NMC, NY.
- Muhlenbergia pulcherrima* Scribn., EE 3638.
- Muhlenbergia utilis* (Torr.) Hitchc., EE 3489 BRIT, NMC, NY.
- Muhlenbergia rigens* (Benth.) Hitchc., EE 3618 NMC, NY; EE 3121 BRIT, NMC, NY.
- Muhlenbergia robusta* (Fourn.) Hitchc., EE 3370 BRIT, NMC, NY.
- Muhlenbergia wolfii* (Vasey) Rydb., EE 3629; EE 3675; EE 3639 NMC, NY.
- Muhlenbergia wrightii* Vasey, EE 3781 BRIT, NMC, NY.
- Panicum bulbosum* H.B.K., EE 3087 NMC, NY; EE 3141 NMC, NY.
- Panicum fasciculatum* Swartz, EE 3097.
- Panicum hirticaule* Presl., EE 3519 NY, BRIT; EE 3087; EE 3541; EE 3546; EE 3783 NMC.
- Panicum obtusum* H.B.K., EE 3520 NY.
- Panicum pampinosum* Hitchc., EE 3087 NMC, NY.
- Paspalum distichum* L., EE 3770 NMC; EE 3537.
- Panicum vaseyanum* Scribn., EE 3203.
- Piptochaetium fimbriatum* (H.B.K.) Hitchc., EE 3013; EE 3746 NY.
- Piptochaetium pringlei* (Beal.) Parodi, EE 3148 NY; EE 3017.
- Poa fendleriana* (Steud.) Vasey, EE 3707.
- Shizachyrium cirratum* (Hack.) Woot., EE 3467 BRIT, NMC, NY; EE 3768 NMC; 3174 NY; EE 3131 NMC, NY.
- Schizachyrium sanguineum* (Retz) Alston, EE 3552 BRIT, NMC, NY.
- Schyzachirium* sp., EE 3554 NMC, NY.

- Setaria grisebachii* Fourn., EE 3014, 3225.
Setaria parviflora (Poir) Kergueten, EE 3219;
 EE 3143 BRIT, NMC, NY; EE 3430 NY.
Sorghastrum nudipes Nash., EE 3585 NY; EE
 3565 NMC, NY.
Sporobolus airoides (Torr.) Torr., EE 3233.
Sporobolus cryptandrus (Torr.) A. Gray, EE
 3492 NY.
- Sporobolus pulvinatus* Swallen, EE 3234
 NMC, NY.
Sporobolus sp., EE 3514 BRIT, NMC, NY.
Triniocloa laxa Hitchc., EE 3666 NMC.
Trisetum deyeuxoides (H.B.K.) Kunth, EE
 3765 NMC; EE 3654 NY; EE 3029;
 3559 NMC.

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CONVENTIONS FOR REPORTING PLANT CHROMOSOME NUMBERS

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ABSTRACT

Original reports of chromosome numbers should reflect actual observations. To facilitate comparisons among taxa, reports of chromosome numbers in floras and other taxonomic works should be uniform.

RESUMEN

Los recuentos originales de números cromosómicos deberán reflejar las observaciones verdaderas. Con el fin de facilitar las comparaciones entre taxa, las citas de los números cromosómicos en floras y otros trabajos taxonómicos deberían ser uniformes.

Because of variations in ways in which chromosome numbers are reported and because untenable statements (such as " $n = 6 \text{ II}$ ") continue to appear in botanical literature, we outline here some guidelines for reporting chromosome numbers in plants, in the hope of encouraging consistency. An important consideration in determining what to report, and how to report it, is context. We recognize two broad contexts in which chromosome numbers are usually cited: original observations and summaries.

ORIGINAL OBSERVATIONS

Reports of original counts of chromosome numbers should precisely indicate what was seen. We report chromosome counts from normal gametophytic cells as n numbers and counts from normal sporophytic cells as $2n$ numbers. We give examples for a group of plants with a base number of $x = 9$:

1. $n = 9$ for counts from mitotic figures in gametophytic cells (e.g., pollen tubes, cells from thalli of fern gametophytes) of a plant of a diploid taxon. Counts of $n = 9$ may also be reported from observations of dyads after cell-wall formation (see also, example 3). While such use of " $n = 9$ " in referring

to a specific observation of chromosomes in cells of a gametophyte would be an accurate notation, a few qualifying words might well be included in the report because chromosome counts are seldom made from gametophytic cells.

2. $2n = 18$ for counts from mitotic figures (usually metaphase) in sporophytic cells (e.g., root-tip cells, leaf-primordia cells) of a diploid plant with $2n = 2x = 18$.

3. $2n = 9 \text{ II}$ for counts from meiotic figures (usually diakinesis or first metaphase) in sporophytic cells (e.g., pollen parent cells, spore parent cells) in a diploid plant. To refer to such counts from sporophytic cells as “gametic” or to cite such an observation as “ $n = 9 \text{ II}$ ” would be incorrect. The single “ n ” should be used only in reference to counts from gametophytic cells. Observations of 9 chromosomes at each pole in incompletely divided dyads of meiotic cells of a diploid plant should be reported as: “ $2n = 18$ (9 at each pole in dyads)” — see also, example 1. In diploid hybrids, less than perfect pairing may be encountered and meiotic figures such as: $2n = 8 \text{ II} + 2 \text{ I}$, $2n = 7 \text{ II} + 4 \text{ I}$, $2n = 18 \text{ I}$, etc., may be seen in plants with $2n = 2x = 18$.

4. $2n = 16$ for counts from mitotic figures in sporophytic cells of a dysploid plant; $2n = 8 \text{ II}$ for counts from meiotic figures in sporophytic cells (e.g., pollen or spore parent cells) of the same dysploid plant. [For discussions of dysploidy and aneuploidy and differences between them, see Dyer et al. (1970), Garber (1972), and papers cited by them. In brief, dysploids are characterized by changes in chromosome number usually accompanied by insignificant, if any, changes in numbers of genes per cell. In botanical literature, dysploid series sometimes have been mistakenly called “aneuploid series.” In aneuploid plants, one or more chromosome(s) of the basic set is represented fewer or more times than expected in each cell and the number of genes per cell is significantly different from that normally found in euploid plants of the same population or taxon. Aneuploid plants are referred to as monosomics, trisomics, etc., usually exhibit greatly reduced fertility, and usually exhibit other traits, including morphological ones, reflecting their genic imbalance. Exceptionally, trisomic plants may be fertile, may form reproductively isolated populations, and may even evolve into distinct taxa.]

5. $2n = 19$, $2n = 17$, $2n = 35$, etc., for counts from mitotic figures and $2n = 9 \text{ II} + 1 \text{ I}$, $2n = 8 \text{ II} + 1 \text{ I}$, $2n = 17 \text{ II} + 1 \text{ I}$, etc., for counts from meiotic figures in sporophytic cells of aneuploid plants, which have certain chromosomes represented fewer or more than the expected number of times in each somatic cell (see discussion at example 4).

6. $2n = 27$ for counts from mitotic figures and $2n = 9 \text{ II} + 9 \text{ I}$, $2n = 8 \text{ II} + 11 \text{ I}$, $2n = 27 \text{ I}$, etc., for counts from meiotic figures in sporophytic cells of

triploid plants, including hybrids. For such plants, statements such as $2n = 27$ may usefully be expanded to $2n = 3x = 27$ to call attention to the presence of 3 sets of chromosomes in sporophytic cells. To report " $3n = 27$ " for such plants would be misleading. Normally, $3n$ cells, $4n$ cells, $5n$ cells, etc., are found only in endosperm tissues, which we consider to be neither gametophytic nor sporophytic.

7. $2n = 36$ for counts from mitotic figures and $2n = 18 \text{ II}$, $2n = 16 \text{ II} + 1 \text{ IV}$, $2n = 9 \text{ II} + 18 \text{ I}$, etc., for counts from meiotic figures in sporophytic cells of tetraploid plants, including hybrids, with $2n = 4x = 36$.

8. $2n = 45$ for counts from mitotic figures and $2n = [\text{various combinations of univalents, bivalents, and/or multivalents}]$ for counts from meiotic figures in sporophytic cells of pentaploid plants, including hybrids, with $2n = 5x = 45$.

And so on for higher ploidy levels.

Reports of "B" or supernumerary chromosomes, or fragments, or rings or chains of chromosomes, etc., can be made by amplifying one of the examples above ($2n = 9 \text{ II} + 2\text{f}$; $2n = \text{chain of } 3 + 8 \text{ II} + 8 \text{ I}$; $2n = \text{ring of } 4 + 16 \text{ II}$; etc.).

SUMMARIES

In floras and some other taxonomic works, in which chromosome number is included in descriptions or in some other bases for comparison, the chromosome numbers given are commonly each derived from more than one observation and are essentially indicators of the ploidy level(s) known for each taxon. We recommend statements such as " $2n = [\text{total number of chromosomes per cell}]$ " for each taxon regardless of the form of the original report(s). In this way a single format allows direct comparisons of chromosome numbers among euploids (diploids and "normal" polyploids), aneuploids, and dysploids.

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NOTES

NOTES ON *HEMEROCALLIS MIDDENDORFFII* (LILIACEAE) IN KOREA

Hemerocallis middendorffii complex (Liliaceae) grows in northeastern China, northern Korea, the central and northern Japanese Archipelago, and parts of the Kuril Islands (Noguchi 1986). As the taxonomy of the complex has been extremely controversial, Noguchi (1986) conducted a detailed study of morphological analyses on 14 characters collected from 35 localities throughout the geographic range of the complex in Japan. More recently, she also investigated the historical differentiation processes of the complex in Japan with chloroplast DNA restriction site variation (Noguchi et al. 1995). For *H. middendorffii* in Korea, only a few locations in northern regions has been documented in previous studies (e.g., Fig. 2 in Matsuoka & Hotta 1966; Fig. 35 in Noguchi 1986; Noguchi et al. 1995). In an attempt to improve our knowledge of the genus, we have collected samples from 75 locations in South Korea during the past 10 years to determine the overall distribution patterns for Korean species and to analyze morphological variation within and among species (Chung & Kang 1994, Kang & Chung 1994, Kang & Chung 1997). Based on these studies, we recognize five *Hemerocallis* species native in Korea: *H. bakuunensis* Nakai (= *H. micrantha* Nakai), *H. thunbergii* Baker (= *H. coreana* Nakai), *H. middendorffii* Tr. et Mey., *H. bongdoensis* M. Chung & S. Kang, *H. taeanensis* S. Kang & M. Chung. Except *H. middendorffii*, the variation patterns of several morphological characters and distribution of the four Korean species have been documented in these studies. From May to June 1995, while conducting field trips in the central and southeastern Korean Peninsula, we encountered three populations of *H. middendorffii* (see arrows in Fig. 1). Samples of rootstocks were collected from the locations and were grown under uniform conditions in Biology Plant Growth Facilities at Gyeongsang National University. Voucher specimens of all collections are deposited at GNUC. From May to June 1996, the 12 morphological characters (Chung & Kang 1994) were measured for 15 individuals from the three populations. In addition, the herbaria of Seoul National University (SNU) and Tokyo University (TI) were visited in order to determine the overall geographic distribution patterns for *H. middendorffii* in Korea. Here we report the distribution and description of *H. middendorffii* in Korea to provide an information for better understanding the complex in east Asia.

Although Matsuoka and Hotta (1966) and Noguchi (1986) presented distribution maps in which the species grows only in northeastern Korea,

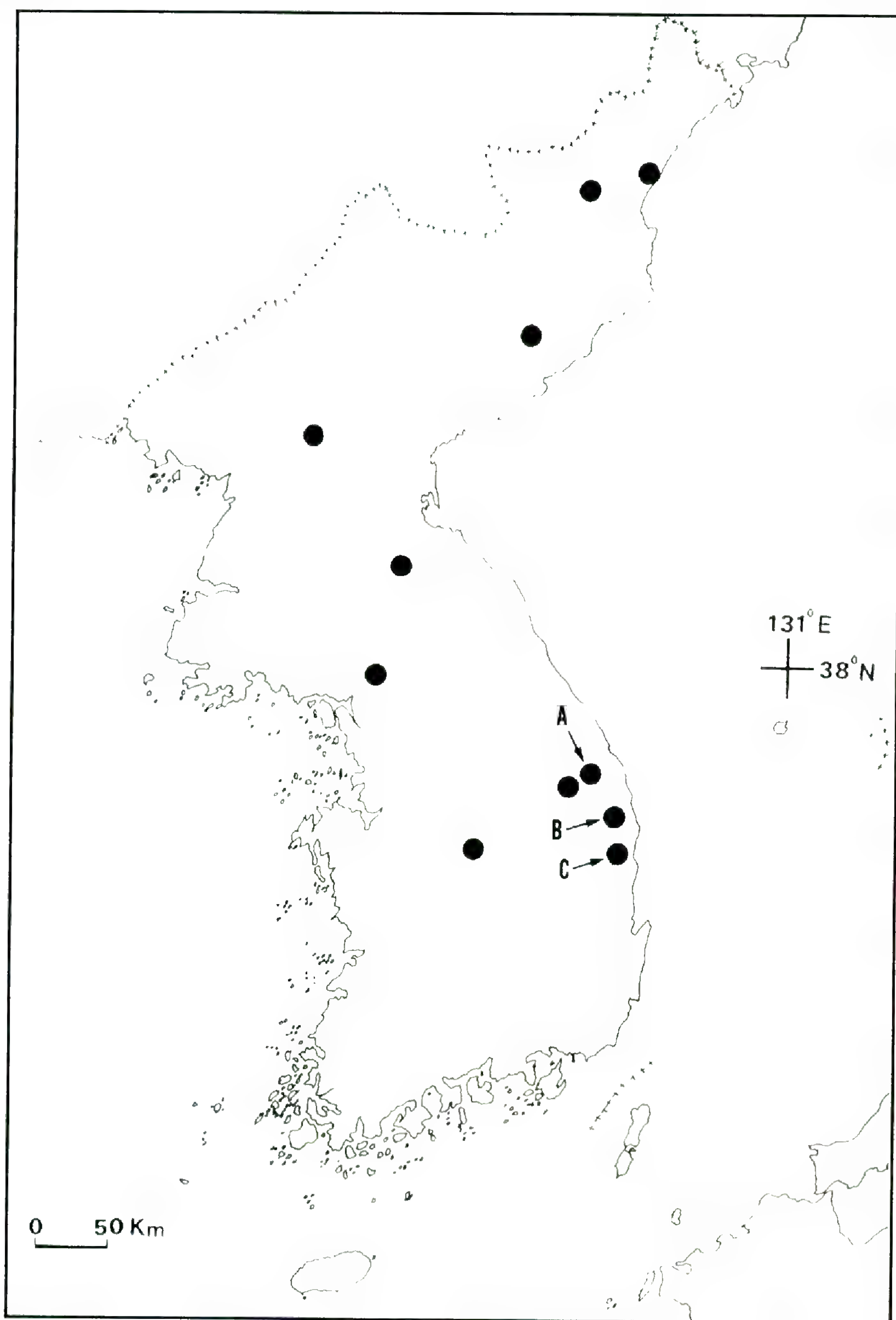


FIG. 1. Documented distribution of *Hemerocallis middendorffii* in Korea. Arrows (A, B, and C) indicate recently discovered populations. Population A (alt. 800 m) grows along a streamside with *Hosta capitata* (Koidz.) Nakai, *Lilium* sp, *Polygonatum* sp., and grasses. Population B (alt. 400 m) grows on the margins of pine forest along a streamside. Population C (alt. 240 m) grows on the hillside of mesoic pine-oak understory.

as presented in Figure 1, *H. middendorffii* is widely distributed from the central to northern Korean peninsula. According to Noguchi (1986), populations of *H. middendorffii* in Japan maintain complex local variation in several morphological characters partly due to diverse ecological habitats such as alpine meadows, low grasslands, and margins of forest understories. Sizes of the three Korean populations were relatively small (< 100 individuals per population) and these isolated populations were found along stream sides of hillsides.

The description of *H. middendorffii* in Korea is as follows:

Hemerocallis middendorffii Traut. & May., Flor. Och. Phaen. 94. 1856.

Leaves 30–60 cm long, 0.8–1.5 cm wide, greenish yellow. Scapes erect, 20–60 cm long. Inflorescences are basically short dichotomous or capitate type with 2–4 flowers. Inflorescence bracts ovate, greenish, 2.5–5.5 cm long, 1.1–3.0 cm wide. Flower weakly fragrant. Perianth orange-yellow, tubular-funnelform, 6.8–9.6 cm long; tube short, 1.0–1.8 cm long; throat orange-yellow, inner perianth lobes 4.6–6.3 cm long, 1.1–2.3 cm wide, outer perianth lobes 4.7–6.7 cm long, 0.9–1.6 cm wide. Stamens 3.5–4.5 cm long, inserted; anthers ca. 5 mm long, dark brown with purple tint. Style filiform, ca. 8.5 cm long, exerted beyond the stamens. Capsule 1.8–2.2 cm long, apex emarginate; seeds shining black, ovoid, angled below, 7 mm long, 5 mm wide. Flowering from late May to June in Korea; fruiting and maturing seed in July.

Specimens examined: **KOREA.** Prov. Hamgyeongbuk-do: Ch'ungjin-shi, 17 Jul 1909, *T. Nakai s.n.* (TI); Mt. Kwanmyobong, 20 Jul 1936, *B.S. Tob* 4507 (SNU). Prov. Hamgyeongnam-do: Sambang, 6 Jun 1933, *B.S. Tob s.n.* (SNU); Mt. Baekam, 15 Jul 1934, *B.S. Tob*, & *H.J. Shim* 3549 (SNU); Musan, Aug 1913, *T. Mori* 311 (TI). Prov. Hamgyeongbuk-do: Mt. Myohwang, 2 Jul 1932, *B.S. Tob*, & *H.J. Shim* 2784 (SNU). Prov. Kyeong-do: Kwangrung, 12 Jun 1932, *B.S. Tob* 900 (SNU). Prov. Ch'ungch'eongbuk-do: Mt. Sokri, *B.S. Tob*, & *H.J. Shim* 9596 (SNU). Prov. Kangwon-do: Mt. Myeon, *S.H. Oh s.n.* (SNU); Mureung-ri, Jungsun-gun, 11 Jun 1995, *S. Kang, M. Chung*, & *G.S. Oh* 2040 (GNUC). Prov. Kyeongsangbuk-do: Bulyoung Valley, Wuljin-gun, 29 May 1995, *S. Kang, M. Chung*, & *G.S. Oh* 2038 (GNUC); Bongwha-gun, 10 Jun 1995, *S. Kang, M. Chung*, & *G.S. Oh* 2039 (GNUC).

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CALYSTEGIA (CONVOLVULACEAE) IN TEXAS

All past Texas floristic works have identified either a single *Calystegia* species, *C. sepium* (L.) R. Br., or at most, two species in the state *C. sepium* and *C. silvatica* (Kit.) Griseb. (e.g., Correll & Johnston 1970; Hatch et al. 1990; Jones et al. 1997). When we recently examined specimens at BRIT for the forthcoming *Shinners & Mahlers Illustrated Flora of North Central Texas* (Diggs et al.), we discovered that there actually were three species, the third being *C. macounii* (Greene) Brummitt. Although there has been marked confusion and misinterpretation of *Calystegia* species in the past (e.g., Tryon 1939), the proper delimitation and names for North American taxa were provided by Brummitt (1965, 1980). Few students of Great Plains plants other than Austin (1986, 1992a) have recognized these three taxa. Other authors have continued an incorrect usage that masked actual biodiversity (e.g., Taylor & Taylor 1989, 1994; Hatch et al. 1990; Jones et al. 1997).

In this note we wish to record the data we have on these species for future students of the region. Details on one or more of these species are also available for the Intermountain region (Holmgren 1984), New Mexico (Austin 1990) and Arizona (Austin 1991). While these taxa differ by what seem to be trivial characters on herbarium specimens, they are more distinctive when alive, have different ecological preferences, and historically occupied somewhat different geographic regions. The following key is modified from Austin (1986).

1. Leaf sinus quadrate (= nearly square); blade tissues not beginning for 2–5 (–10) mm from petiole attachment (only vascular tissue near attachment) *C. silvatica* subsp. *fraterniflora*
1. Leaf sinus V- or U-shaped; blade tissues beginning at the point of petiole attachment.
 2. Basal lobes of leaf blades with 1–2 small, tooth-like angles; plants normally glabrous or with a few trichomes on petioles *C. sepium* subsp. *angulata*
 2. Basal lobes of leaf blades rounded; plants normally pubescent on all vegetative parts.
 3. Plants twining throughout; leaf blades narrow (mostly 3:1 length to width ratio) *C. sepium* subsp. *limnophila*
 3. Plants semi-erect or sparsely twining; leaf blades broad (mostly 2:1 length to width ratio) *C. macounii*

Calystegia macounii (Greene) Brummitt, Ann. Missouri Bot. Gard. 52:215. 1965. BASIONYM: *Convolvulus macounii* Greene, Pittonia 3:331. 1898. TYPE: CANADA. SASKATCHEWAN: Assiniboia, Milk River, Aug 1895, *John Macoun* 11883 (HOLOTYPE: ND; ISOTYPE: BM).

The semi-erect habit and strongly inflated floral bracts make *C. macounii* distinctive. Parker (1972, Fig. 111B p. 233) incorrectly illustrated this species as *C. sepium*. So far as known, that is the only published drawing of

C. macounii. This is a Plains species that is distributed from Canada to western Minnesota and south to Texas, New Mexico and Arizona. Probably the plants were spread westward along logging railroads across New Mexico and Arizona. Because so few people have identified the species, little of its ecological preferences are known. However, *C. macounii* is typically associated with moist sandy soils near waterways in open grasslands or openings in woodlands. Also, this is the first species to flower in the spring, usually in May and June. Although flowering periods overlap, this species is often in fruit by the time the others begin to flower.

TEXAS. Cooke Co.: Silty bank, above small stream, limestone area, 8.8 mi W of Gainesville, 13 May 1951, *L.H. Shinn* 13256 (BRIT-SMU).

***Calystegia sepium* (L.) R. Br. subsp. *limnophila* (Greene) Brummitt**, Ann. Missouri Bot. Gard. 52:216. 1965. BASIONYM: *Convolvulus limnophilus* Greene, Pittonia 3:29. 1898. TYPE: CALIFORNIA. Suisun Marsh, Aug 1883, *E.L. Greene* 39709 (SYNTYPE: ND fide Brummitt, cf. Austin 1992b). *Convolvulus repens* L., Sp. Pl. 158. 1753. TYPE: specimen 218.55 in herb. Linnaeus (LINN, not seen; microfiche seen). *Calystegia sepium* var. *repens* (L.) A. Gray, Syn. Fl. N. Amer. 2(1):215. 1878. (cf. Tryon 1939; Correll & Johnston 1970: 1247). *Convolvulus nashii* House, Muhlenbergia 5:66. 1909. TYPE: FLORIDA. LAKE CO.: Eustis, *Nash* 609 (HOLOTYPE: Colombia Univ., not seen; ISOTYPE: NY).

The leaf blades abruptly narrowed (mostly 1–2 cm wide) above the exaggerated sagittate bases make this subspecies distinctive. Rarer specimens (e.g., *Boon* 130 & *Webster* 487) have leaves wider than this but usually still have the flared sagittate bases making them identifiable. This is a wetland species that ranges from Florida to California across the southern USA and even into northern Mexico.

TEXAS. Aransas Co.: N of Fulton, 10 Jun 1960, *F. Jones* 4086 (TEX). Galveston Co.: Park on F.M. 517 (Bayshore Drive) S of Bacliff, 10 May 1976, *F. Waller* 3810 (TEX). Harris Co.: 5 mi NW of LaPorte, 24 Jul 1943, *E. Boon* 130 (TEX). Jefferson Co.: Beaumont, 9 Apr 1924, *B. Thayer*? 3163 (TEX). Orange Co.: Port of Orange, 27 Jun 1967, *D. Correll* 34279 (LL). Terrell Co.: 7 mi upstream from jct. of Independence Creek & Pecos River. 5–6 Jul 1949, *G. Webster* 487 (TEX).

***Calystegia sepium* (L.) R. Br. subsp. *angulata* Brummitt**, Kew Bull. 35:328. 1980. TYPE: IDAHO. CANYON CO.: Fells Store, 28 Jun 1910, *Macbride* 318 (HOLOTYPE: MO; ISOTYPES: GH, NY, US).

Both *C. sepium* and *C. silvatica* are climbing or twining plants. Although the floral bracts are inflated in *C. silvatica*, its habit and leaf characters are different from those of *C. macounii*. Leaf characters, as noted in the key, distinguish *C. sepium* from *C. silvatica*. *Calystegia sepium* subsp. *angulata* belongs to a disturbingly variable complex that has probably been properly segregated into taxa by Brummitt (1965, 1980). Unhappily, Brummitt

has never published a full account of how to distinguish the varieties and it is known that some intergrade (Brummitt 1980). Subspecies *angulata* is native from New Brunswick to British Columbia in Canada and south to Washington, Oregon, Idaho, Utah, New Mexico, Texas and South Carolina in the U.S.A. (cf., Brummitt 1980 for specimen citation). This is a woodland and forest taxon typically confined to openings and glades; it usually flowers between June and August.

TEXAS. Jefferson Co.: ca. 8.5 mi W of Sabine Pass, from a sand dune area near the beach, 24 May 1973, *J. Taylor & C. Taylor* 13242 (BRIT-SMU).

***Calystegia silvatica* (Kit.) Griseb. subsp. *fraterniflora* (Mack. & Bush.) Brummitt, Ann. Missouri Bot. Gard. 52:216. 1965.** BASIONYM: *Convolvulus sepium* (L.) R. Br. var. *fraterniflorus* Mack. & Bush, Man. Fl. Jackson Co. Missouri 153. 1902. TYPE: U.S.A. MISSOURI: Martin City, 9 Jul 1899, *Mackenzie & Bush s.n.* (not traced; TOPOTYPE, 28 Jun 1905, *Bush* 3037 (GH, MO).

The quadrate sinus in the leaf blade base is the easiest way to recognize *Calystegia silvatica* subsp. *fraterniflora*. This North American subspecies, related to the Old World *C. silvatica* subsp. *silvatica*, is native from New Hampshire to Kansas and Florida to Oklahoma and Texas. Within that region it typically occurs along stream margins on sandy soils in deciduous forests. This species has the longest flowering season of the three, often going from May to September.

TEXAS. Anderson Co.: E of Palestine, 2 Oct 1965, *D. Correll & H. Correll* 31748 (LL). Chambers Co.: rare along brackish marsh in the Anahuac National Wildlife Refuge, S of Anahuac and on shore of Galveston Bay, 5 Jun 1987, *L.E. Brown* 11155 (BRIT). Ochiltree Co.: bank of Wolf Creek, 12 mi SE of Perryton on US 83 & 5 mi E of hwy., 13 Jul 1957, *C. Wallis* 4849 (SMU). Potter Co.: Palo Duro Cañon-Harding Road. 15 Jun 1929, *B. Tharp* 6289 (TEX).

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HETEROTHECA LATIFOLIA (ASTERACEAE),
NEW TO THE FLORA OF IOWA

Heterotheca latifolia Buckl. (Asteraceae: Astereae) is a taprooted yellow-rayed annual native to open sandy sites from the southern Great Plains and Ozark region to northern Mexico, which is sporadically naturalized farther north and east (Wagenknecht 1960; Harms 1965; Rolfsmeier et al. 1991). Plants of this species (referable to var. *macgregoris* B. Wagenkn.) were recently collected for the first time in Iowa.

Voucher specimens: **IOWA:** Lee Co.: Montrose Twp. T66N R5W sect. 3 W1/2, along railroad tracks paralleling US Hwy 61, just N of the Linger Longer Rest Area, 1 mi N of Montrose, scattered in dry sand prairie with scattered junipers, on slope overlooking the Mississippi River, 3 Oct 1997, T.G. Lammers 10499 (F, ISC, NY, TEX).

The site is a relatively undisturbed dry sand prairie of a few acres extent, situated on a moderate slope from US Highway 61 to railroad tracks, on a terrace of the Mississippi River. This prairie is dominated by *Panicum virgatum* L. and *Eragrostis trichodes* (Nutt.) A. Wood (10495), with a few scattered trees of *Juniperus virginiana* L. (10496).

I first visited this site nearly 20 years ago, on 17 May 1978. That early in the season, the only species in flower were *Androsace occidentalis* Pursh (1493), *Corydalis micrantha* (Engelm.) A. Gray (1494), *Draba reptans* (Lam.) Fern. (1492), and *Viola rafinesquii* Greene (1495). Another early-season stop a year later, on 2 June 1979, added only *Delphinium virescens* Nutt. (2715). The opportunity to make a visit later in the season did not present itself until recently. It was on this occasion that the *Heterotheca* was discovered. Other psammophiles collected at the same time included *Ambrosia psilostachya* DC. (10498), *Croton glandulosus* L. var. *septrionalis* Muell.-Arg. (10501), *Helianthus petiolaris* Nutt. (10497), *Polanisia dodecandra* (L.) DC. (10503), and *Triplasis purpurea* (Walt.) Chapm. (10494).

Gleason and Cronquist's (1991) manual, which includes Iowa within its scope, does not mention *Heterotheca latifolia* as either an accepted species or a synonym. Apparently, these plants were included in their concept of *H. subaxillaris* (Lam.) Britt. & Rusby, as was done by most authors prior to Wagenknecht's (1960) revision. In any event, no species of *Heterotheca* section *Heterotheca* was reported from Iowa in Wagenknecht's (1960) revision of the group. Neither *H. subaxillaris* nor *H. latifolia* was included in the recent checklist of Iowa vascular plants (Eilers & Roosa 1994). No species of the genus was reported from the southeastern corner of the state by Davidson (1959), nor from Lee County by Peck et al. (1981).

Despite its occurrence as part of a relatively undisturbed native plant

community, the population of *Heterotheca latifolia* var. *macgregoris* in southeastern Iowa is presumed to be naturalized and not native, based on its disjunction from the main range of the species and its proximity to road and rail transport. The nearest approach of native populations of this taxon is in eastern Kansas; more proximate populations in Illinois and Missouri are considered introduced (Wagenknecht 1960; Harms 1965). The nearest Illinois population of that taxon reported by Mohlenbrock (1986) and Mohlenbrock and Ladd (1978) is in Henry County, 115 km to the northeast. The nearest Missouri population mapped by Steyermark (1963) is in St. Louis Co., approximately 230 km south-southeast; however, those plants are referable to var. *arkansana* B. Wagenkn. (Wagenknecht 1960; Steyermark 1963).—*Thomas G. Lammers, Department of Botany, Field Museum of Natural History, Chicago, IL 60605-2496, U.S.A.*

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CERASTIUM PUMILUM AND STELLARIA PALLIDA (CARYOPHYLLACEAE) NEW TO TEXAS

Early-flowering annual members of the Caryophyllaceae are often overlooked in the North American flora. *Cerastium pumilum* Curtis and *Stellaria pallida* (Dumort.) Crép. are no exception, especially since they resemble widely distributed weedy species; *Cerastium fontanum* Baumg. emend Jalas and *Stellaria media* (L.) Villars respectively.

During a collecting trip in May of 1997, Reznicek made six collections of various species of Caryophyllaceae. Of these six, two were taxa not previously reported from Texas (Correll & Johnston 1970; Turner 1996; Jones et al. 1997).

***Cerastium pumilum* Curtis** (CURTIS' or DWARF MOUSE-EAR CHICKWEED) has been reported from disturbed areas in many of the eastern and southeastern United States (Rabeler & Cusick 1995), including Missouri (Steyermark 1963), Arkansas, and Tennessee (Rabeler & Thieret 1988). It is now being reported from Texas from the following collection:

TEXAS. Kaufman Co.: roadside ditch, E side of FR 205, 0.7 mi NW of jct. with TX Hwy 80, W side of Terrell, 32°44'48"N, 96°18'19"W, 2 May 1997, A.A. Reznicek 10336, S.D. Jones, & S.A. Reznicek (BRCH, MICH).

Plants were found in moist, bare soil of lower slopes of a disturbed grassy/sedgy ditch along with *Cerastium glomeratum* Thuill., *Sagina decumbens* (Elliott) Torrey & A. Gray, and *Myosurus minimus* L.

Cerastium pumilum resembles a small plant of *C. fontanum* and will key to *C. fontanum* in Turner's key to Texas *Cerastium* (Turner 1996). The two species can be separated by the following couplet:

1. Flowers 8–10 mm wide; petals deeply notched (to 1/2 the petal length); sepals pilose, seldom glandular-hairy; stamens 10; capsules mostly over 8 mm long; perennial, often with non-flowering basal shoots *C. fontanum*
1. Flowers 5–6 mm wide; petals shallowly notched (to 1/4 the petal length); sepals glandular-hairy; stamens 5 (rarely 10); capsules less than 8 mm long; annual *C. pumilum*

***Stellaria pallida* (Dumort.) Crép.** [= *Stellaria media* subsp. *pallida* (Dumort.) Asch. & Graebn.] (LESSER CHICKWEED) is also a plant of disturbed areas. Like *Cerastium pumilum*, it has been reported from a number of nearby southeastern United States including Arkansas (Thomas et al. 1991) and Tennessee (Chester et al. 1997). It is now being reported from Texas from the following collection:

TEXAS. Hopkins Co.: roadside, NW corner of jct. of Hopkins Co. Rd. 2401 & TX Hwy 11, ca. 3 mi SE of Pickton, 32°59'58"N, 95°21'10"W, 3 May 1997, A.A. Reznicek 10361, S.D. Jones, & S.A. Reznicek (BRCH, MICH).

Plants were found in dry, sandy, open soil of a disturbed roadside growing under *Petrorhagia dubia* (Raf.) G. López & Romo, another somewhat recent (1960s) introduction to the Texas roadside flora (Rabeler 1985).

Stellaria pallida will key to *S. media* in many floristic manuals, including Correll and Johnston (1970). The two species can be separated by the following couplet:

1. Plants green, rarely yellowish green; flowers usually open, with petals; sepals 4 mm or longer, uniformly green; seeds dark brown, (0.8–)0.9–1.3 mm in diameter, the surface covered with rounded papillae *S. media*
1. Plants yellowish green; flowers usually cleistogamous, apetalous; sepals seldom over 3 mm long, often with a red basal band; seeds yellowish brown, 0.5–0.8 mm in diameter, the surface covered with acute papillae *S. pallida*

The most consistent features distinguishing *S. pallida* from *S. media* are the color, size, and surface of the seed (Morton 1972; Rabeler 1988). Unfortunately, many specimens (including *Reznicek 10361*) lack the red band at the base of the calyx which, when present, allows immediate recognition of *S. pallida*.

Rabeler and Cusick (1995) discussed the authorship of *S. pallida*, noting that, contrary to many sources, Piré did not publish the combination *Stellaria pallida*. The next usage of the combination they were aware of was by Junger in 1878. After that paper appeared, Rabeler learned, as Kent (1997) noted, that Francois Crépin made the combination twelve years earlier (Crépin 1866) than Junger.

Both of these plants are probably recent introductions and, as Rabeler has noted in other reports of these species (Rabeler 1988; Rabeler & Cusick 1995), are likely to be found elsewhere in similar disturbed areas.—Richard K. Rabeler, rabeler@umich.edu, and Anton A. Reznicek, reznicek@umich.edu, University of Michigan Herbarium, North University Building, Ann Arbor, MI 48109-1057, U.S.A.

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IN MEMORIAM
LYNN LOWREY
(1920s?—28 June 1997)

Courtesy: Native Plant Society of Texas. Native Pl. Soc. Texas News 15(5), September/October 1997

REMEMBERING LYNN LOWREY

by Dr. David Creech

Lynn's passing June 28, 1997, was a hard blow to the gardening world. Another mighty oak has fallen. A living legend is gone. For many of us Lynn was one of those folks you run across in life you want to end up like. I knew Lynn from the late 60s as a TAMU Horticulture major working in the fruit science end of the program and, as a graduate student at TAMU, I crossed trails with him many times in the 70s. I was then looking for various native and exotic fruits adapted to East Texas conditions (pawpaws, blueberries, hawthornes, jujubes, etc.) and Lynn was the man to see. From TAMU to SFA and then the Arboretum and suddenly Lynn's footprints and mine crossed much more often. Trips to Mexico, to the backwoods, to nurseries, to gardens or just out and about with other plant friends was part of the plan. Simply put, from the beginning, Lynn struck me as a genius with character.

For many of us, Lynn really was a legend in his own time. His impact on southern landscapes reaches almost as far as his effect on people. I could never decide if Lynn was born 100 years too late or too early. Both fit. Always a quiet reservoir of plant knowledge, always eager to learn and share, Lynn was blessed with humility and great humanity. His expertise was unquestioned; whether it was a botanist, horticulturist or adventurous landscape designer visiting the state, Lynn was always high on a list of people to see. Lynn was more a true plantsman than a true nurseryman. Hard for him to stay in one spot, hard for one to make a firm appointment with, Lynn liked to wander here and there collecting seed or plants. He enjoyed connecting with someone who knew about this or that plant or that person who was working with ...

Throughout his career—and there's no point in recounting all the names and locations of Lynn's nursery haunts—Lynn brought adventure and excitement to the nursery and landscape industry in the south. The Mexico oaks are only the tip of the iceberg. Many gardens across the south are blessed with living memorials to the oh-so-many plants that Lynn showered on the world. Who can't appreciate Lynn's big leaf yaupon? The Arboretum's Lynn Lowrey American Holly selections—cuttings grown from superior East Texas trees—are now robust 10' females with large berries and clean foliage.

There's that special Oakleaf hydrangea sporting large tresses and good fall color over by the perennial border; it deserves a name—collected by Lynn near Angola Prinson in Louisiana. Lynn felt that the *Wisteria frutescens*, our native Westeria—white and blue forms—were worthy of greater use and certainly easier to manage than those rude Japanese and Chinese cousins. Hmmm...what about the soapberry with exceptionally narrow leaves? What about the *Hesperaloe* from Mamuluke pass? The Mahonias? For those of us who knew him, the list never ends. And that is what Lynn would want us to think about him when we thought about him—the plants.

Lynn's impact amazes many of us academic and non-academic types who write and speak for a living in the amazing gardening world of Texas. Lynn wrote little and spoke

less. Yet, his followers are legion. The power of his message was more than just the plants. It was an attitude to live by. Before it was politically correct, Lynn spoke and wrote quietly on biodiversity, taking advantage of microhabitats, and understanding the importance of site preparation, plant community development, natural form in design, using superior and adapted natives and exotics. One day Lynn and I were working along a fence row south of Navasota off a red clay road, collecting seed and cutting from a bright orange-berried, deciduous holly that mixed into a swarm of native trees and shrubs and herbaceous and God knows what. Lynn said that he didn't see how you could much improve on where we were at—kind of God's design.

While Lynn was no doubt an adventurous gardener, he didn't stop there. He also became a role model to live by. I always felt that business to Lynn—even money—was just a distraction, something that had to be dealt with as little as possible. Down deep, he'd rather give away plants than sell them. Lynn's goal in life was to work at what he loved to do and share it with the world. Lynn did that better than anyone. Perhaps more important than the plants or the gardens, maybe Lynn's greatest talent was in putting people together. Whether connecting medical researchers and cancer foundations with rare cancer-fighting plants like the Happy tree of China, or locating *Taxus globosa* in the mountains of Mexico for the Arnold Arboretum, or hunting down a particular genotype for a botanist, or chasing down a natural hybrid between two related genera—Lynn was always there to help out—to make something happen. Amazing to me, he never thought much about all this. He seemed to think he wasn't really doing all that much, that everyone else was doing a lot of good or that others work was "really important." That's what Lynn saw in people—the good. I think all the people, plants and gardening did that to him. Matt Welch, one of my students, gave me this quote the day after the Lowrey memorial and the message kind of stuck. "Maybe a garden is not like an artistic creation, but more like a relationship. It is not so much designed as it is nurtured and managed. Imperfections, inconsistencies, and incongruities say that the relationship has some vitality to it, and that the gardener is engaged in a dialog and doesn't need to have the last word."—Tom Little, 1996. Lynn Lowrey never even intended to have the last word; his gardens, his plants and his people will do it for him.

See also:

Bisbee, B. 1995. The Lynn Lowrey Legacy. Native Pl. Soc. Texas News 13(5):5–6.



Lynn Lowrey



Benny Simpson (center).

IN MEMORIAM
BENNY J. SIMPSON
(29 February 1928—27 December 1996)

Courtesy: Native Plant Society of Texas. Native Pl. Soc. Texas News 15(2), March/April 1997

PIONEER OF THE NATIVE PLANT MOVEMENT
by Jill Nokes

Last night a stranger called me. He was a tree trimmer by trade, and had been thumbing through *A Field Guide to Texas Trees* by Benny Simpson, saw my name listed with others in the foreword, and called me on impulse because he wanted to know more about this man Benny. "How does he know that this particular tree is only found on gypsum outcrops? I want to find out more about him. Where does he live? Do you think he'd let me follow him around some day when he's out lookin' at trees?" When he finally paused, I once again had the sad task of telling someone that Benny had died on Friday, December 27 of complications following heart surgery. The tree trimmer man had missed knowing a most generous and special person.

Benny was born on the leap year of 1928. Last year we joked that he was only 17 years old instead of 68, since his birthday only rolled around every four years. He was born in Northfield, in Motley County, to parents Una and Baker Simpson, who were ranchers in the rolling High Plains part of the state that always held a special place in Benny's heart. He was one of 15 students in his graduating high school class and attended Texas Tech college at 16, majoring in agronomy and farm machinery. Later he joined the marines, barely missing action in the Korean War. He began working at Texas A&M University Research and Extension Center in Dallas in 1954 when it was the Texas Research Foundation, a private agricultural organization. Texas A&M took it over in 1972.

Early in his career Benny was in charge of planting crops that were being studied by other researchers at the Center. Although his job required him to supervise years of futile cotton root rot studies on the Blackland Prairie, the passion and interest for native plants and the Texas landscape he had since his days as a boy on the ranch began to take shape. On his own in the 1970's he began to collect and plant various native woody plants and find left over plots at the Center to establish field trials for some of these specimens to see how they would adapt to a situation outside their normal range. In the early days, he had to defend his work and ever-growing arboretum from being plowed under each season, because at that time Texas A&M did not see the value in studying native plants.

By the time of his death Benny had finally received some of the recognition for his visionary and steadfast work. His research led to the selection of nine superior selections of native plants released to the nursery industry (see accompanying article by Tim Kiphart). As he neared retirement, there was concern about how best to preserve his arboretum, which was by then very substantial. In a tribute to his work, plants from his collection were donated to the Heard Natural Science Museum in McKinney, Texas. A plant collection of 345 plants in 84 genera representing more than 20 years of his research was also established in his name at the Dallas Horticultural Center at Fair Park. And finally, at the Research and Extension Center, where he'd worked for 42 years, plans began last fall to establish the Benny Simpson Outdoor Learning Center. The Center is situated in the lovely wooded area which had been part of his field trials. Apart from these gardens, Benny was also the recipient of many awards from garden clubs, universities and professional organizations.

Perhaps Benny's greatest legacy was the influence he had over a whole generation of horticulturists, botanists, plant enthusiasts and finally, the TAMU System itself which began supporting more research into the use and development of one of our state's most overlooked resources. A big factor motivating Benny's research was his understanding (as perhaps only one who had lived on a ranch knows) that scarcity of water will be one of the biggest challenges in Texas' future. Today, especially after the drought of '96, the existence of water rationing and the acceptance of xeriscape landscape programs, the public is beginning to understand what was always obvious to him.

Benny was one of the founders of the Native Plant Society of Texas in 1982 and was very active in the organization until his death. He donated royalties from his book, *A Field Guide to Texas Trees*, to the Native Plant Society of Texas. For several years he underwrote the cost of the cover photography on the *Proceedings* of the NPSOT annual meeting. It was his idea to initiate the annual awards and to rotate the location of the annual meeting each year to a different vegetational region in order to increase awareness of the spectacular variety of our native flora. Benny worked hard to organize the wonderful program we had last October in El Paso. Many thought it was our best annual meeting yet and all of us were disappointed when he could not attend.

I was a bewildered graduate student in 1973 when I first met Benny. I had a shoebox full of 3x5 index cards with notes scrawled about propagation and use of a random number of native woody plants. I had a vague idea that gathering as much of the scattered information from books and oral sources about these plants would be useful somehow, but I had no scientific background and no clue how to go about it. From the beginning Benny saw the value in this project beyond what I had imagined. He supported me and instilled confidence. He offered all the knowledge that he had painstakingly accumulated throughout the years. He encouraged me as I slogged through a 600 page master's thesis, which eventually became a book. He read both manuscripts and let me know that he was very proud of me. He was the kind of friend who can see what you can accomplish and has faith in you even when you have trouble believing in yourself.

We all made the common mistake of assuming we would have Benny with us forever. Benny was working on a book on native shrubs, as a companion to his tree book. As of now we don't know how close it was to being finished or if we will have a chance to benefit from all the work he put into it. Sally Wasowski has about a dozen more books to write and was depending on having the help he had always offered on her other projects. Mary Anne Pickens, as president of NPSOT, was counting on his guidance beginning her new term. We assumed he would shape the program for NPSOT's annual meeting in Uvalde next October, highlighting one of his favorite parts of the state, the Rio Grande Plains. Additionally, Dr. Ted Davis and Dr. Wayne MacKay intended to video tape Benny touring his arboretum hoping to capture information about his plants, their provenance, habits, history and cultivation he held in his head.

Benny's legacy to us is still unfolding and being revealed. Just as the plants in his gardens grow, so will his influence on new students and researchers. It's clear that even the general population won't go back to being indifferent about what landscape plants they will use. For me, my consolation comes everytime I look at one of his photographs (or see someone planting a shrub he selected and grew) and I hold that picture in my heart of him standing next to the plant the first time he saw it in the field. He is wearing a beat up straw hat, a white shirt with suspenders, khaki pants stuffed into Justin boots and a big smile on his face. Thank you, Benny. You gave us so much. Thank you and farewell.

Note: Benny is survived by his mother, two sisters, a brother, four nieces and one nephew. The

family asked that memorials be made in Benny Simpson's name to the Native Plant Society of Texas. A memorial service to celebrate Benny's life was held on February 8 at Texas A&M University Research and Extension Center in Dallas.

BENNY SIMPSON'S LEGACY TO NPSOT

by Mary Anne Pickens

Benny Simpson was a founding father and former president of NPSOT. He helped define the goals of NPSOT and wet the organization in motion. He served as the Master of Ceremonies of our annual meetings. He put together our symposium proceedings. He had a clarity of vision that he didn't mind sharing. He kept us on course.

And what is the course? Please refer to his President's Corner of September/October 1994.

Benny would not like for me to take up too much space quoting him, but he spoke of fiscal responsibility as being the Board of Director's number one task. Second on his list for us was an "attractive, informative newsletter." Number three was "our annual State Meeting at which the flora of one vegetational area" is studied each year. Fourth on his list of duties was "to conduct the quarterly business meetings with meaningful decorum and dispatch."

Upon becoming president of NPSOT he had made three proposals: (1) Seek a memorandum of understanding with Texas Parks and Wildlife with the view of selecting certain parks, conducting plant surveys of those parks and publishing a vascular plant inventory; (2) Each Chapter should work up a vascular plant inventory of garden worthy native plants within a 50-mile radius of that chapter; (3) Using the above list, each chapter should plant a small flower garden or arboretum.

By the end of his term, he said, "Proposal 1 is out ... too time consuming ... we are not really qualified to do. Proposal 2 should be easy and a lot of fun. Proposal 3 hopefully you'll think about and one or two chapters may do it."

So where are we on Benny's proposals? We altered Proposal No. 1, and with Tim Kiphart's diplomatic skills simply signed a two year memorandum of agreement (MOA) with Texas Parks and Wildlife encouraging continued or increased NPSOT chapter members' participation in TPWD's projects stewarding native plant resources.

Proposal 2 is still easy, but how many of us have done it? If your chapter has done it, has the chapter filed the inventory with the NPSOT state office so that it is a matter of public record?

Proposal 3 should be one of our memorials to Benny. With the stimulus provided by the Wray Foundation in our mini-grant program to encourage native plant demonstration gardens, we can move forward. Recognizing Benny's legacy to NPSOT, David Todd, board member of the Wray Foundation, asked that this year's grant money be recognized as a memorial to Benny Simpson. I suspect Benny would say, "Great! Start planting those gardens—with natives found within a 50 mile radius!"

I don't always see things as clearly as Benny did. Black and white frequently blend into shades of gray for me. But for clarity of vision, I always go back to NPSOT's mission statement: to promote the conservation, research and utilization of the native plants and plant habitats of Texas through education, outreach and example. Benny recognized two ways to clearly accomplish the mission—produce a first class newsletter and provide an outstanding, stimulating, ever challenging annual symposium.

On a state level, we do those two things. But through our local chapters there are many

ways of accomplishing the mission and meeting the objectives. Brazos Valley meets it when it collects acorns to propagate trees for Mother Neff State Park. Houston, Mercer, and Dallas Chapters meet it when they man a booth at the TAN show. Trinity Forks meets it when it restores a wildflower meadow in a burned area within a city park. Bandera Chapter meets it when it gets the Highway Department to designate an area as a Native Area not to be mowed. Kerrville Chapter meets it when it installs and maintains a native garden at the public library. Columbus Chapter meets it when it does the same in Beason's Park on the Colorado River. Austin Chapter meets it when it has a booth at Eco Fair. Within each chapter lies the seed of potential growth for meeting NPSOT's goals.

I think our mission is quite simple—plants. We study them, we encourage the research on them, we respect them, we promote their conservation. We encourage others to do the same. If we carry out this mission, we do not need to waste time and money on anything else. Keep Benny in mind. Clarity of vision is something we all need. I will work on conducting “quarterly business with decorum and dispatch!”

BENNY SIMPSON'S PLANT LEGACY

by Tim Kiphart

Combine botany and horticulture and what do you get? The life of a research horticulturist. Our guest: Make Mother Nature better and look for the botanical oddities she produces. It's what we thrive on!

Plant selection takes a keen eye. Benny Simpson worked on that for 45 years. Working for the same place your whole life - how bizarre. The things you do for love!

Benny was responsible for introducing about a dozen plants into the nursery trade. He looked for qualities that made a great plant even better: form, color, flower size, resistance (insect, disease, heat, cold)—you name it. All the selections Benny made were of western (Trans-Pecos) species. This is where he felt most at home.

The most well known of Benny's introductions are the *Leucophyllums* - the “Cloud” series. In almost every part of the state someone has planted Texas purple sage. It certainly is the evergreen backbone in the western half of Texas. Two selections of *L. frutescens*, two of *L. candidum* and a hybrid species all show Benny's thumbprint. *Leucophyllum frutescens*, “Green Cloud,” is a green leaf form of this typically gray leaf shrub. It is much more tolerant of irrigation—a big plus for the nursery industry. Millions of “Green Cloud” have sold. Because of the atypical white flower “White Cloud” is unique. You can imagine how choice the porcelain white flowers look against the gray foliage. Both selections are large 5-6' shrubs.

A stunning shrub in the wild, *L. candidum*, is difficult to grow in a landscape. Dwarf silverleaf sage is about 3' tall and has iridescent silver foliage. In addition, its grape colored flowers make an awesome landscape display. The two selections of *L. candidum* are “Silver Cloud” and “Thunder Cloud.” They are respectfully named for their exceptional foliar quality and explosive bloom.

The last of the series is “Rain Cloud”, a hybrid between *L. minus* and *L. frutescens*. It caught on more in Arizona than Texas. What a shame! It has the height of *L. frutescens* and the darker purple flowers of *L. minus*. Responding very well to rain it produces masses of flowers.

Desert willow was another species Benny made selections on. This shrubby tree is native to arroyos but has proven quite adaptable in the landscape. It is even listed in nursery catalogs from the 1860's, making it a native heritage plant. *Chilopsis linearis*, “Dark Knight”, is purple rather than the typical pink and “White Knight” is a fine, pure white, showing a yellowish throat.

Another multi-trunked shrub, *Amorpha fruticosa* var. *angustifolia*, "Dark Lance," is a much underutilized plant. The bloom is reminiscent of a fox tail, but displays dark indigo-purple with orange anthers. It is a wonderful habitat plant, not to mention a big hummingbird attraction.

Benny was never much on perennials. He was a manly man! But, why then did he love frog fruit? Two perennials come to mind though—one official and one non-official, both *Salvias*. Officially speaking, *Salvia regla*, "Mount Emory" is unsurpassed. Not only does "Mount Emory" have more cold tolerance, the leaves are a darker, more lacquered green. The other perennial Benny spread around was *S. greggii*, "Lancaster Hill" (not official). A violet-pink bloom with a white throat sets this *greggii* apart. It's like a beacon shining in the landscape.

Other plants Benny was working on include Mexican buckeye, Evergreen sumac, Mexican redbud, Wax myrtle and a hybrid Kidneywood. These plants are still under evaluation.

The plant introductions were only the tip of the iceberg. Benny was responsible for turning people on to many more plants than he introduced. He loved his plants and it was this love that propelled him through life. Well, my friend, may you forever walk the desert of your dreams.

BOONDOCKING WITH BENNY

by John Mac Carpenter

Benny J. Simpson was almost certainly familiar with more of Texas Wild than anyone else in the history of the state. He explored every corner of it with his friends, who counted themselves lucky to be along. Many of you I know, but many I don't. Our common friends included Mary Buchanan, an uncommon woman, Dean Ricer and Mark Rosacker of New Mexico's Living Desert State Park, John White, formerly of El Paso, and Wayne MacKay, currently of El Paso, and most important of all, Dr. Barton H. Warnock (Doc) of Alpine.

Benny and Doc and I spent many precious days together studying and collecting plants, walking desert washes, climbing hillsides, checking along watercourses.

The gypsum sand dunes west of the Guadalupe in Culberson county were one of our most spectacular visits. On one memorable visit Benny and I met Wayne MacKay, Dean Ricer and Mark Rosacker at the Lynch Ranch offices in Dell City to pick up the key and get directions. It drizzled all day, but the temperature stayed in the upper 70's so it was comfortable. Mountains surround the broad plain containing the dunes, El Capitan just to the east the most spectacular, but the Cornudas being the most interesting looking. The snowy white sand was a perfect backdrop for the rosemary mint, supposedly *Poliomintha incana* but reaching five feet tall. In the moist air, the scent of the leaves was delicious. Benny kept saying "I could live here." For peace and beauty, these dunes are near the top of the list.

Benny always called when it had rained. He knew spring comes in the Trans-Pecos whenever rain comes. He'd arrive about three weeks after a rain and we'd go looking. I picked him and Sue Tracy up at the airport once in Iran and we went to Lancaster Hill overlooking the Pecos River in Crockett county. This is where Hill country meets Big Bend country. This is a prime site for cliff Fendler bush, one of Benny's favorites. From this spectacular spot you can look across old Fort Lancaster into the burned mesa country that I love with its crooked streak of green in the foreground that is the river.

Benny and Doc and I checked out Mohr oaks and Mexican redbuds on the launch in Terrell county while smelling the sweet scent of the algerita in full bloom. Some of the

Mohr oaks along Big Canyon are true trees instead of small shrubs. He found desert ceanothus in Pinto Canyon in Presidio county, *Quercus polymorphy* on Dolan's Falls Ranch on the Devil's River, roses in the Guadalupe and Davis Mountains, and cenizo that no one else could propagate, he moved from the dry hills of the Trans-Pecos to the nurseries and to our yards.

A favorite place in the western part of the state for us is Mesquite Ranch on the southwest slope of the Chinati Mountains in Presidio county. Doc and Benny and I spent many days there, walking hillsides, canyons, arroyos and climbing up Chinati peak. San Francisco is the prettiest place, with its Thurber penstemon and frequent water. All the washes and canyons on the ranch are lined with *esperanza*, *Tecoma stans*, v. *angustata*, and canyon senna, *Senna wislizenii*, which is spectacular in bloom. There is also Arizona cockroach plant, *Haplophyton crooksii*, smaller but just as pretty and poisonous to cockroaches. The walnut trees in Pelillas arroya are intermediate between *Juglans major* and *Juglans microcarpa*.

We were eating lunch one day at the ranch headquarters and visiting with Al Real, the foreman, while Benny told us about his new hearing aid. We'd noticed he was hearing better than usual and he told us how it differed from earlier models. When he finished I asked him what kind it was and he, pulling up his cuff, said, "A quarter till two."

Benny was always the emcee at our annual meetings until 1996 when he didn't feel well enough. For a field hand, he cleaned up real good and was as much at home at the podium as in a swamp, a woodland or a desert wash. He looked a lot better too and could charm a garden club or educate scientists.

Benny left us a lot to work with and a lot of memories. Most of us are growing at least one of the plants he moved from nature to nurture and will always have something of him around. I regret the days I had expected to spend with him in the breaks along the edge of the Caprock when he retired to home in Motley county.

Una, you gave us a winner and we appreciate the gift.

In loving memory, John Mac Carpenter

Courtesy: Dr. Tim Davis, Texas A&M University Research & Extension Center Texas A&M University System, Dallas, Texas.

BENNY J. SIMPSON

Research Scientist

Texas A&M University Research & Extension Center

Texas A&M University System

Dallas, TX 75252-6599

B.S.: Texas Technological University (Agronomy and Farm Machinery)

1954–72: Junior to principal soil scientist farm superintendent, Hobilizelle Agricultural Laboratory, Texas Research Foundation, Renner.

1972–76: Farm manager, Texas Agricultural Experiment Station.

1976–80: Research scientist, farm manager, Texas Agricultural Experiment Station

1980–1996: Research Scientist, Texas Agricultural Experiment Station.

Project H-8164 "Resource Efficient Plants for Texas and the South West" is concerned with the development of genetically superior ornamentals for Texas. This mission is approached in two ways: by cooperation with other scientists in testing their material and by basic research on new plants not now in the nursery trade. The major thrust is with superior selections of Texas native plants that will be low users of fossil energy and water. Propagules of these plants are collected in the wild (seeds or cuttings), increased to greater numbers and tested for adaptation. While undergoing adaptation

studies, further cuttings and seed are taken for propagation, fertility, consumptive water and other investigations.

HONORS AND AWARDS

The President's Award, Texas Woman's University Tenth Annual Texas Wildflower Day; Donovan Stewart Correll Memorial award in the field of scientific writing for the book, *A Field Guide to Texas Trees*.

The Silver Seal Award, National Council of State Garden Clubs, Inc.; Charles Woddle Wildflower Distinguished Lecturer, Texas Tech University.

CAREER MAJOR ACCOMPLISHMENTS

Release of Plant Varieties and Other Genetic Materials:

Leucophyllum frutescens, 'White Cloud' Cenizo.

Leucophyllum candidum, 'Silver Cloud' Cenizo.

Leucophyllum frutescens, 'Green Cloud' Cenizo.

Chilopsis linearis, 'Dark Storm' Desert Willow.

Chilopsis linearis, 'White Storm' Desert Willow.

Salvia regia, 'Mount Emory' Mountain Sage.

'Renner' Weeping Lovegrass. (J.C. Read, B.J. Simpson, and L.J. Streetman)

Leucophyllum minus x *L. frutescens*, 'Rain Cloud' Hybrid Cenizo.

Leucophyllum candidum, 'Thunder Cloud' Cenizo.

Amorpha fruticosa var. *angustifolia*, 'Dark Lance' False Indigo.

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